THURSDAY, JULY 30, 1891.

THE HISTORY OF CHEMISTRY.

A History of Chemistry from the Earliest Times to the Present Day. By Ernst von Meyer, Professor of Chemistry in the University of Leipzig. Translated by George McGowan. (London: Macmillan and Co., 1891.)

OF all branches of natural science, none has a history more profoundly interesting or more fascinating than chemistry. And yet, strange to say, none has received less adequate treatment from the historian. The reason for this comparative neglect is not far to seek. The historian of science must have qualifications which are rarely united in one man: not only must he possess the attributes of the successful writer on social, political, or economic history, but he must also be a past-master in the special branch with which he deals, and be well informed on all its cognate branches. Germany has given us the classical volumes of Kopp; from France comes the learned work of Hoefer; whilst in England we have had, until quite recently, to be content with the somewhat trivial, disjointed, and partial narration of Thomas Thomson. In addition we have had a number of monographs, especially within recent years, on the labours of particular individuals: many of these, like Henry's "Dalton," Wilson's "Life of Cavendish," Bence Jones's "Life and Letters of Faraday," and the remarkable series of biographical sketches which we owe to the facile pen of Hofmann, are delightful works; but these, after all, are only *mémoires pour servir*. As a rule, the more formal and general histories which deal with the organized growth of the science are not very attractive; either their authors lack literary grace and charm, or they are superficial, ill-informed, and, in some cases, so obviously biassed as to render them altogether untrustworthy. And, moreover, not one of them has sought to grapple with the splendid achievements of the last half-century in any truly philosophic manner. Kopp and Hoefer have, between them, told us all that is known, or, in all probability, ever will be known, or need be known, respecting the beginnings of chemistry, and of its growth through the Middle Ages, and down to the end of the last century. We now require somebody to set about doing for this nineteenth century what the German and French historians have done for those that precede it. The labour would be stupendous, but the result might be magnificent. At no period in the history of the science have its generalizations been more brilliant, and its theories more comprehensive, more prolific, and, it may be added, more securely established. The birth of the century saw the extension of the atomic hypothesis to the explanation of the fundamental facts of chemical combination, and it has been the chief and most characteristic work of the century to place that theory on a foundation as sound and as firm as that on which the immortal conception of Newton is based. The historian of the chemistry of the nineteenth century need have no other text than that of the atomic theory; for round this dominant conception all other present-day theories are ranged; it is the centre of a system which it vivifies and feeds, and by which it itself is fed and strengthened in return.

Some attempt at what is here foreshadowed has been made in the book before us, but, excellent as the work is in many respects, it is even more suggestive of what remains to be accomplished. The book is divided into six chapters, of which the fifth and sixth are devoted to the history of chemistry from the death of Lavoisier to the present time, and these two chapters occupy nearly three-fourths of the volume. This portion is not only the larger, but is confessedly the most difficult of the whole. In weighing and criticizing current chemical doctrine, and in discussing the theories of the present, even the most conscientious historian is apt to be unconsciously biassed by the predilections and prejudices of his training and environment. Prof. von Meyer has not been unmindful of this possible danger, but after carefully reading his work we can heartily congratulate him on the success with which he has preserved the "objective attitude" which is essential to the true historian. As he tells us, it has been his earnest desire to shed a clear light upon the conflicting views respecting the development and importance of the chemical doctrines of to-day, and to endeavour to apply a calmer and juster criticism to the services of eminent investigators of quite recent years than has hitherto, in many cases, been meted out to them. It is possible that we apprehend Prof. von Meyer's meaning the more fully when we state that such a catholicity of sentiment and so judicial a temperament have not always characterized the occupant of the Chair of Chemistry in the University of Leipzig.

For the two chapters which treat of modern chemistry we have nothing but unqualified praise, and we earnestly commend them to the attention of those students who desire to have a *coup d'œil* at once comprehensive and accurate of the meaning and tendency of present-day doctrine. When we have regard to the enormous mass of material which has to be systematized, and, as it were, brought within focus, some errors and omissions are inevitable. And it is possible that here and there a slight lack of balance and due proportion may be discerned: some matters have been treated at comparatively great length, whilst others have been but scantily noticed. On this point differences of opinion are sure to arise: *tot homines, tot sententiæ*. But no candid reader can fail to be impressed with the singularly fair and impartial manner with which Prof. von Meyer has dealt with the labours of contemporary workers. It is a pleasure to read a work in which the writer has been superior to the petty Chauvinism which has disfigured certain historical productions of the last twenty years. We would specially indicate the critical notices of the labours and services of Lavoisier, Berzelius, Davy, Dumas, Liebig, and Wöhler, as models of historical acumen, sound judgment, and rigid candour. On the time-honoured question, "With whom should rest the merit of the discovery of the composition of water?" Prof. von Meyer is scrupulously just and impartial. He shows that Lavoisier was so far dominated by his *principe oxygine ou acidifiant* that, in burning hydrogen, "he expected to find an acid as the product of its combustion, and therefore looked for one. It is the undisputed merit of the phlogistonist Cavendish to have

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proved that water alone is produced by the combustion of hydrogen" (pp. 157-58).

Although he devotes only two chapters to it, it is obvious that it is the main purpose of Prof. von Meyer's work to trace the development of chemistry from the downfall of phlogistonism onwards, and he has therefore only dealt with the earlier periods in order to give the reader a connected view of the growth of the science. This portion of the work is touched with a comparatively light hand, and in some respects compares unfavourably with the rest. Although at times there are graphic sketches—as, for example, in the account of Palissy's work, and in the estimate of Bergmann's services to analytical chemistry, and in the story of that strange compound of truculent charlatanry, gross mysticism, and strong common-sense, who called himself Philippus Aureolus Paracelsus Theophrastus Bombastus — the general impression is not wholly satisfactory, and to trace the historical connection of the several epochs presupposes more knowledge than Prof. von Meyer imparts. It is hardly possible to do justice to the age of alchemy in 40 pages, or to the history of the iatro-chemical period, which includes the work not only of Paracelsus and his school, but also that of Van Helmont, George Agricola, Palissy, and Glauber, in 30 pages. But with the "Geschichte der Chemie" before him, Prof. von Meyer may well have hesitated to plough with the patient heifer of Hermann Kopp.

In his fourth chapter, where he deals with the period of the phlogiston theory, the author begins to expand somewhat, but occasionally, we venture to think, at the expense of strict historical accuracy. Thus it is not strictly true to say that Kunkel laboured "for years" to discover the secret of the preparation of phosphorus (p. 141), or that Cavendish defended the phlogistic theory "with all his might" (p. 118). That singularly austere and passionless person—that "cold clear Intelligence," as Wilson calls him—was utterly incapable of entering the lists as the champion of any theory. He let his Irish friend Kirwan, to whom it was more congenial, do all the fighting. It is hardly correct to describe the calm and philosophic Priestley as "eccentric and of a restless fiery nature." No man gave and got harder knocks in his time than did the kind-hearted, even-tempered old philosopher; he, too, did his fighting "all in the way of business," hitting straight and above belt, and with no malice in his blow; but to call him "eccentric," or "restless and fiery," reveals an entire misconception of his disposition and character. The occasion of Lavoisier's admission into the French Academy is only partially stated, and it is not wholly true to say that amongst all his numerous friends and admirers only one chemist, Loysel, had the courage to protest against his execution (p. 153).

A word in conclusion as to the manner in which Dr. McGowan has done the work of translation. His aim, he tells us, has been to reproduce clearly the sense of the German original, and in this he has, no doubt, succeeded admirably. But a purist might object that, in his efforts to preserve the sense, he has too carefully retained the idiom. To say that "the absorption of medicine in chemistry, the fusion of both together, was the watchword which emanated from Paracelsus" (p. 3) is scarcely a happy method of expression. Nor is this paragraph much better:—

"Spirit of wine—the *aqua vitæ* of the alchemists—continued to grow in importance during the iatro-chemical age, as it had done in the alchemistic. This applied to it not merely from a theoretical point of view, as being a product of various fermentation processes to which much attention was paid, but also from a practical, since Paracelsus and his disciples used it largely in the preparation of essences and tinctures" (p. 95).

On p. 101, Boyle's manor in Dorsetshire is erroneously called "Stolbridge," and on p. 185 "Dalton" is incorrectly printed for "Davy." Such terms as "centrepoint" and "fire-stuff" are not current English. Dr. McGowan's duty as a translator doubtless required him to say that "the nobility and poetry of his [Davy's] nature are shown both in the journals which he kept during his extensive travels in France, Germany, and Italy, and in his beautiful relations to Faraday" (p. 187); but the veracious historian, familiar with the annals of the Royal Institution, would probably have expressed himself differently.

T. E. THORPE.

PROGRESS IN ELEMENTARY BIOLOGY.

Lessons in Elementary Biology. By T. Jeffery Parker, B.Sc., F.R.S., Professor of Biology in the University of Otago, New Zealand. (London: Macmillan and Co., 1891.)

PROF. JEFFERY PARKER is to be congratulated on having produced an extremely well-written, well-considered, and original class-book. The teaching of so-called "elementary biology" has, in consequence of the coercion of examination schedules and the multiplication of little cram-books dealing with the selected and protected "types," become in this country a very poor thing. The practical work in the laboratory with frog, fern, rabbit, and worm, which was, when first introduced, a step in advance, has become, like so many other things which were good in their origin, a tyranny and an impediment to knowledge. Students have resolutely shut their eyes to all facts but those presented by the schedule types, and teachers of a certain class have seen the easiest way to secure "examination results" in ignoring the generalizations of biology, and in plying their pupils with the regulation details as to the few animals and plants scheduled for dissection. Prof. Parker's book should help to remedy this state of things. His aim has been, he states, to supply the connected narrative which would be out of place in a practical hand-book. I agree with him that the main object of teaching biology as part of a liberal education is to familiarize the student not so much with the facts as with the ideas of science. In this little book the student will find many of the most important conceptions of biological science set forth and illustrated, not by reference merely to the types which he dissects or examines with greatest ease in the elementary course in a laboratory, but by the use of a larger area of well-chosen examples, both of plants and animals. Original woodcuts, often of exceptional merit, are freely introduced in the text.

Whilst the plan of Prof. Parker's book is excellent, I cannot help feeling some regret that he has not carried

it out on a somewhat larger scale, so as to make his volume represent for the biology of to-day what the classical "Comparative Physiology" of Dr. Carpenter did for the biology of forty years ago. The defect just alluded to—if it be a defect—is one which can very well be remedied hereafter, since the author will undoubtedly have an opportunity of expanding his book in every direction in a later edition.

Nearly half the book is devoted to the consideration of the phenomena of life as exhibited by unicellular organisms—the Protozoa and Protophyta. There can hardly be any doubt that this is by no means an undue proportion, since it is unquestionable that in these simplest forms the fundamental problems of biology present themselves in the clearest light. We have well-illustrated chapters on Amœba, on Hæmatococcus, on Heteromita, on Euglena, on the Mycetozoa, and then a comparison of the foregoing organisms with certain constituent parts of the higher animals and plants, viz. cells. The minute structure and division of cells and nuclei are fully treated and well illustrated. Then follow separate chapters on yeast, on bacteria, on biogenesis and abiogenesis, and on the more complicated unicellular animals—the Ciliata, from among which are chosen Paramœcium, Stylonichia, Oxytricha, Opalina, Vorticella, and Zoothamnium. A chapter on species and their origin, and the principles of classification, comes next, the illustrative examples being chosen from among the Protozoa already described. The Foraminifera, Radiolaria, and the Diatomaceæ are then brought under consideration. In every chapter the organism or group of organisms treated is made to serve as the concrete basis of a gradually expanding and connected narrative. Thus, in passing to the consideration of such forms as Mucor, Vaucheria, and Caulerpa, the author says:—

"The five preceding lessons have shown us how complex a cell may become, either by internal differentiation of its protoplasm or by differentiation of its cell-wall. In this and the following lessons we shall see how a considerable degree of specialization may be attained by the elongation of cells into filaments."

A pause is now made, and a brief but thoroughly up-to-date chapter is inserted on "the distinctive characters of animals and plants." Prof. Parker thinks there is a great deal to be said in favour of Haeckel's third organic kingdom—the Protista. I do not agree with him in thinking that it is probable that the earliest organisms were "protists," and that from them animals and plants were evolved along divergent lines of descent.

If we approach this question, not with the attempt to define plants and animals verbally, but with the object of indicating probable lines of descent, the groups sometimes considered as doubtful, and therefore "protist," take rank with great probability either in the animal or the vegetable series. The Mycetozoa and the Volvocineæ fit quite naturally in the animal series; they would be isolated among the Protophyta, and, conversely, the Bacteriaceæ are inseparable from the Oscillatoriæ and other filamentous green plants.

Prof. Parker next proceeds to deal with plants of increasing complexity of structure and function—Penicillium, Agaricus, Ulva, Laminaria, and Nitella; and, as a parallel to these in the animal series, we have two chapters, with excellent woodcuts, on Hydra and on the Hydroid polyps, their colony-building and their alternation of generations. The extremely important facts and theories of spermatogenesis and oogenesis and of fertilization are next set forth, briefly but clearly, and in sufficient detail for the general purposes of the book. In connection with the early development of the fertilized egg-cell of the Metazoon from its unicellular phase to the condition of the diblastula, the question is considered as to how we are to suppose that the passage took place historically from Protozoa to Metazoa or Enterozoa. It is pointed out that there is a break here in the series of living animals known to us, whilst there is no corresponding break in the series of plants: there we pass by insensible gradations from unicellular forms to linear aggregates of cells, and from these to superficial and to solid aggregates.

The *Magosphæra planula* described by Haeckel in 1870 is cited as an animal tending to bridge over the gap in the animal series, but a footnote informs the reader that "unfortunately nobody has since seen this organism." Prof. Parker probably is aware that this is also true of Haeckel's *Protomyxa aurantiaca*, which he figures and describes in an earlier chapter. It certainly is to be regretted that neither of these interesting organisms has been observed again since they were described by Haeckel. However, *Volvox globator* is always with us, and Prof. Parker gives an excellent set of figures and a description of it, and proceeds to show how a two-cell-layered sac—the ancestral gastrula or diblastula—might have been derived from such a colony. He also shows how a primitive diploblastic form might have developed from a multi-nucleate Protozoon, such as Opalina or Oxytricha.

In the laboratory it is convenient to take the Earthworm as an example of that central type of structure which is found under various modifications in all the Cœlomate animals. Prof. Parker, rightly separating himself from the ties of laboratory work, prefers the marine worm Polygordius for his illustration of this grade of structure, choosing it partly on account of its greater simplicity, partly on account of its extremely interesting and well-studied developmental history. As the author contends, a student who reads the two chapters here devoted to the anatomy, physiology, and development of Polygordius, will have an immense advantage either in his subsequent study of the Earthworm, or in reverting to his notes of a previous dissection of that worthy beast. The principle of the comparative method will be revealed to him, and he will learn to distinguish things essential from things non-essential.

Next, with a rush, having scaled the long ladder leading to Polygordius, Prof. Parker takes his reader in one chapter of seventeen pages through the anatomy and morphology of the starfish, the crayfish, the mussel, and the dogfish. This seems and is rather rapid, but the rapidity is intentional and justifiable. By the aid of *this* book the student is intended only to gain a general view of the structure of those animals as comparable to that of Polygordius. For further details he must go on to the special study of animal morphology, physiology, and embryology; or having studied these subjects more or less, he may, by aid of Prof. Parker's clever sche-

matic woodcuts, gain a vivid impression of the unity of organization and the divergence in minor points of structure of the higher animals when compared one with another. Perhaps, however, in that enlarged edition of this book which will at no distant date appear, Prof. Parker will treat the higher animals less unceremoniously; this he might do, and yet retain that conciseness and regard for the essential which form an admirable characteristic of his method.

Mosses and Ferns are treated as the parallel among plants of Polygordius in the animal series; and in a single chapter Equisetum, Salvinia, Selaginella, Gymnosperms, and Angiosperms are surveyed (and excellently illustrated by finished woodcuts) in such a way as to give the student an accurate and highly effective survey of the great features of vegetable morphology and physiology.

Such is the outline of these "Lessons." Their merit, however, consists not merely in the general plan, but in the fact that the author is an experienced teacher and an accomplished investigator, who has developed to a high degree the art of lucid statement—one who is thoroughly familiar with the latest researches in the wide field of which he treats, and is able, whilst setting before his reader the most important generalizations of his science, to avoid redundancy, and to give a fresh and original handling to the oft-told story of the structure and functions of living things.

E. RAY LANKESTER.

CEREBRAL LOCALIZATION.

The Croonian Lectures on Cerebral Localization. By David Ferrier, M.D., LL.D., F.R.S., &c. With Illustrations. (London: Smith, Elder, and Co., 1890.)

IN these valuable lectures, Dr. Ferrier reviews the subject of cerebral localization, so far as the representation of movement and of special sense is concerned. After referring categorically, in the first of the series, to the historical experiments on the subject, arranged in order of chronological sequence, he points out the fundamental principles embodied in the term cerebral localization. Leaving the discussion of motor representation, he devotes the remaining five lectures to the consideration of the cortical representation of the special senses, beginning with that of sight.

The representation of sight is, according to all observers, mainly restricted to a definite area of the cortex. The differentiation of that area and its topographical subdivision are points of the highest interest, and naturally do not escape discussion. We are rather surprised, however, to find that Dr. Ferrier is not prepared to admit that Munk and Schäfer's experiments, besides those of other observers, establish visual representation to be situated in the occipital lobe, but is inclined to believe that the angular gyrus is the centre for clear vision mainly for the eye of the opposite side. Upon this we would only remark that it does not appear to us that the mass of evidence relating to crossed hemianopsia, whether of experimental or clinical nature, can be put aside as easily as Dr. Ferrier would seem to consider possible, but those interested in the subject will find many of the facts bearing on this question referred to in his treatment of the points at issue.

So, too, with the representation of audition, while all (save Schäfer's and Sanger Brown's) observations support Dr. Ferrier's views of the seat of representation of hearing, it would undoubtedly have been better that the rebutting evidence brought against the exceptional facts referred to should have consisted of a number of experiments, and not of a single one, even although that seems to have been a very conclusive observation.

After disposing of the centre of audition, the tactile centre receives attention, and is preceded by a discussion of the paths along which afferent impressions travel in the spinal cord to the higher centres. Of course, this subject has been very actively investigated by various observers for many years, but it has always appeared to us that sufficient attention has never been given to the simple consideration whether or not the *lower* centres are engaged in the transmission of such impulses. In the limited space at Dr. Ferrier's disposal he has evidently not been able to give this matter full discussion, and is therefore led to assume that Brown Séquard's dictum respecting the passage of afferent (tactile, not painful) impulses up the opposite side of the cord holds good. This question is now being reinvestigated, and the preliminary observations published by Mott and others throw very grave doubt on the validity of this assumption, which has so long been accepted as final.

As regards the representation of common tactile sensation in the cortex cerebri, Dr. Ferrier discovered that it was probably represented in the hippocampal region, and he reviews the results of his experiments, as well as those of Schäfer and Horsley, which tended to show that the gyrus fornicatus, as well as the hippocampus, were the seat of tactile perception, and he concludes that possibly the whole limbic lobe is concerned with this representation.

As regards, however, the representation of sensation in the excitable or motor part of the cortex, he will "have none of it." Here, again, we are afraid that the considerations of time and space, which always handicap subjects treated in lecture form, account for the fact that the critical examination of this question is not so complete as perhaps it might have been made.

On the whole, these lectures well maintain the author's high reputation as a keen observer, and an indefatigable student, gifted with singular clearness and distinctness of expression, and they will well repay perusal by all who wish to follow the progress of knowledge of cerebral localization and its most important bearings.

OUR BOOK SHELF.

Education and Heredity. By J. M. Guyau. (London: Walter Scott, 1891.)

THIS small and excellently-translated work is a posthumous publication, written by a Frenchman who died four years ago at the early age of thirty-three. He was a fluent and prolific writer, the author of no less than fourteen other publications, and is described in the introduction as a philosopher and poet. It would seem from this book that the latter temperament was his prevalent characteristic. Its prevalent literary style and the originality both of metaphor and of handling will commend itself, and so will the account of recent hypnotic in-

vestigations, and the use made of them in the argument. Interesting and appropriate quotations are inserted from numerous authors of fame and notoriety, as from Plato, Descartes, Leibnitz, and Spencer, down to Tolstoi. But when, after reading right through the book, one asks oneself what has been the net gain, what new ideas it has given, or what valuable facts it has brought together, and what are its solid and original arguments, it is rather difficult to give a satisfactory reply. The book chiefly consists of well-phrased "talkee-talkee," so that some readers may feel a little grateful to so fluent and prolific a writer that he stopped his nimble pen even as soon as he did. One has become nowadays rather satiated with *a priori* deductions.

As for the "Heredity" in the title, it is nowhere in the book, except at the end of one chapter, where neither the author in the text nor the translator in the footnotes has shown any misgiving concerning the truth of the old supposition of the free inheritance of acquired faculties, which greatly affects the argument of the work. Undoubtedly some few men of high authority still entertain the older view, but the majority of students of heredity now regard it as unproved, and at the best, that the inheritance is very slightly efficient.

The following paragraph will serve as an example of what is least good in the author's style and method:—

"Why then should not the representation of man, by hereditary tendency, excite in man himself a peculiar pleasure, and an inclination no longer of flight, but to approach, speak, be helped, to put others in his place? When a child falls under the wheels of a carriage, we precipitate ourselves to its rescue by an almost instinctive movement, just as we should start aside from a precipice. The image of others is thus substituted for the image of ourselves. In the scales of the inner balance, *I*, *thou*, are constantly interchanged. This delicate mechanism is partly produced by heredity. Man is thus domesticated, made gentler, and more civilized; now he is partially savage, partially civilized or civilizable. The result of education through the ages is thus fixed in heredity itself, and this is one of the proofs of the power possessed by education, if not always for the present, at least for the future."

Life is short, there is much to learn, and economy of time is important. It is questionable whether it is worth the while of a person who has some acquaintance with the subject of this book to spend half a working day in reading it, for he might not find it as nourishing as he would wish. Still it is not unlikely that those to whom the subject is unfamiliar would gain instruction from the book and would consider it throughout to be interesting.

F. G.

The Soul of Man: an Investigation of the Facts of Physiological and Experimental Psychology. By Dr. Paul Carus. (London, Edward Arnold.)

IT is in vain that a puzzled reader seeks to discover the aim of this book. It is entitled "The Soul of Man," but no explanation is given as to what is meant by the title; and at the end of forty-six rambling and discursive chapters on things in general, the reader finds himself no wiser. It is called "an Investigation of the Facts of Physiological and Experimental Psychology," but there is no investigation of facts in the book. The rudiments of anatomy, of embryology, of neurology, &c., are set forth, much in the form in which they can be found in elementary text-books on the subjects, but the facts thus presented are not investigated; they are presented in no new light, no new conclusions are drawn from them, and the object of their presentation does not appear. Here and there, indeed, the author states a belief for which in the preface he claims originality; he considers, for instance, that consciousness (which he calls a concentrated or intensified feeling—an additional element that sometimes is, and sometimes is not, attached to mental operations) is "produced" in the corpus striatum. It does not appear, however, that this hypothesis leads to anything, or has any appreciable bearing on the "problem of the human soul," whatever that may be. Dr. Carus thinks, too, that man has two souls, a central soul and a peripheral soul; and it is thus that he explains the familiar fact that certain purposive actions are unattended with consciousness; but we cannot say that this explanation makes the matter any clearer. As a contribution to science, the book cannot be commended. Whether it has a theological value, we must leave to others to say.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Recent Earthquakes in Italy.

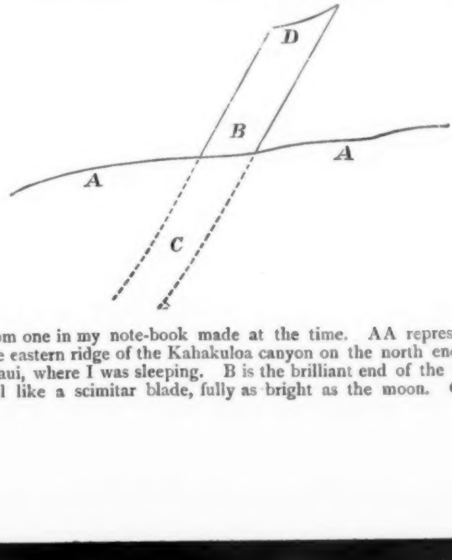
WITH reference to the letter which appears in your issue of July 23 (p. 272), on the earthquakes having occurred at Vesuvius on June 7, and on the same day in Southern Australia, I would ask leave to point out that the localities mentioned lie in the vicinity of a great circle which I call the "south-west coast of Australia great circle" (that is, the coast-line between Cape Hamlin and Cape Chatham). Melbourne would be about 370 miles north of its direction, and it cuts Italy in the neighbourhood of Catanzaro, leaving Vesuvius about 65 miles to the north. This great circle is one of maximum compression on the earth's surface—that is, it lies for the most part on the ocean surface, its greatest extent on land being in traversing Arabia, which it crosses in a north-west, south-east direction.

It is also worth noting that, while you cite in the same issue two shocks as having occurred in the Æolian Islands on June 24 (of these, Stromboli lies about 40 miles south of the direction of this great circle), there was recorded on that day, in the newspapers, an earthquake shock as having taken place on the 23rd (midnight) at Charleston, South Carolina, which lies about 650 miles to the north-west of the direction of the great circle in question at this point, and therefore approximatively in the vicinity. J. P. O'REILLY.

Royal College of Science for Ireland,
Stephen's Green, Dublin, July 24.

The Great Comet of 1882.

IN your issue of May 28 (p. 82) is a communication about the comet of 1882 as seen in the act of passing close to the sun. As attention has thus been called to that comet, I desire to report a remarkable peculiarity of the tail as observed by myself, October 3, 1882, about daybreak. It was my first view of this glorious comet. Other persons on the east sides of the islands had seen it several days earlier. The peculiarity noted was the *abrupt ending* of the tail, which was cut off sharply at an oblique angle, on an incurved line. The following representation is copied



from one in my note-book made at the time. AA represents the eastern ridge of the Kahakuloa canyon on the north end of Maui, where I was sleeping. B is the brilliant end of the vast tail like a scimitar blade, fully as bright as the moon. C is

copied from my note-book. It was evidently meant to indicate the continuation of the tail towards the nucleus, as seen on subsequent mornings, when farther from the sun. D is the terminal edge of the tail, as sharp as the outer limb of the moon, and of fullest strength of lustre. Altogether it formed a rather appalling apparition. Clouds soon obscured it. No farther view was obtained for two or three days, when the end of the tail had assumed the usual misty, indefinite outline.

The conclusion forced upon my mind was that the comet, having parted with its tail in its rapid turn at the perihelion, was seen in the act of forcing out a new one ahead of itself, in a solid bank of vapour, the front of which might be compared to the wall of water that heads a freshet in a stream. Another resemblance suggested was that of the solid-looking outline of an up-rolling cumulus cloud.

I will add hereto a statement made to me at the time by the Rev. Hiram Bingham, a distinguished pioneer missionary to the Gilbert Islands. He saw the comet about a week earlier than myself, from Kaneohe, on the east side of Oahu. Both he and his wife observed *waves of prismatic colours running outward* along the brilliant tail. Mr. Bingham is a highly cultivated person, and having commanded the missionary ship for part of two years, is accustomed to lunar and stellar observation. I was led at the time to believe that there was no optical illusion in what he saw. SERENO E. BISHOP.

Honolulu, June 30.

Copepoda as an Article of Food.

PROF. HERDMAN'S practical demonstration at the North Cape confirms a theory I have long held, that the Copepoda, which abound in every ocean, sea, and lake, might be largely and advantageously made available for human food. It is well known that the species *Calanus finmarchicus*, so abundant in our northern seas, forms the chief food of the Greenland whale. Our own immediate coasts abound in this and other equally edible species. During a recent dredging cruise round the Isle of Man, each pull of the tow-net contained thousands of another and larger species of Copepod, *Anomalocera patersonii*; and Dr. John Murray has found that a still larger species, *Euchæta norvegica*, is plentiful in the lower depths of several Scotch lochs.

A number of finely-meshed trawls, used off the west coast of Ireland, would, I am convinced, furnish excellent food for starving multitudes in time of need.

A propos of the distribution of Copepoda, my attention was called a few days ago by the Mayor of Bootle to the filter-beds of the town salt-water baths, which he said were swarming with Entomostraca. The water is supplied direct from the river, and examination showed the presence of Copepoda in enormous quantities, the bulk of them being *Eurytemora hirundo*, a species only once before taken in Britain, and then in near proximity to Bootle. Probably other filter-beds are equally prolific, and may prove valuable hunting-grounds, the Copepoda undoubtedly acting as scavengers in keeping the water pure from putrefaction. I. C. THOMPSON.

Liverpool, July 24.

Meteorological Phenomenon.

I HAVE received in a letter from a friend residing in Boraston, Shropshire, the following account of a remarkably interesting meteorological phenomenon, which is well worth putting on record:—

"We had a curious sight from this house yesterday [July 26]. It was a dead calm, but in a field just below the garden, with only one hedge between us and it, the hay was whirled up high into the sky, a column connecting above and below, and in the course of the evening we found great patches of hay raining down all over the surrounding meadows and our garden. It kept falling quite four hours after the affair. There was not a breath of air stirring as far as we could see, except in that one spot." FRANCIS GALTON.

Refraction through a Prism.

IN such elementary text-books on geometrical optics as I have consulted it has always seemed to me that the writers have found a difficulty in presenting a precise direct proof of the theorem that when a ray is turned out of its course by direct passage through a prism, its deviation is least when its path is symmetrical with regard to the prism.

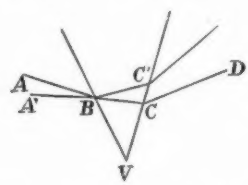
May I ask you to consider the simple proof which I inclose, and may I leave it to your judgment whether it is worth while that it should be presented to the notice of teachers in the pages of NATURE? My knowledge of text-books I cannot suppose to be exhaustive, and the arrangement of the proof which I inclose of course may not be any novelty.

JOHN H. KIRKBY.

Radley College, Abingdon, June 11.

Minimum Deviation.

The problem is to find two rays which, passing directly through a prism near together, have their directions changed by the prism to the same amount—for in the limit, these, when brought into coincidence by change of position of the prism, will mark the course of that ray which suffers minimum deviation (experiment may be appealed to, to show that it is minimum



and not maximum). Let ABCD be the course of a ray of light through the prism whose vertex is V. At B make the $\angle$ VBC' = $\angle$ VCB, then if the ray BC' is continued out of the prism on both sides, it is evident that its completion D'C'BA' meets and leaves the faces of the prism at exactly the same angles as the original ray ABCD, only in the opposite direction. Thus the two rays ABCD, A'BC'D' suffer equal deviation, and because the Δ's VBC, VC'B are similar,

$$\therefore \ VB^2 = VC \,.\, VC';$$

and when the rays are so close as to practically render C, C' coincident, we have $VB^2 = VC^2$, or VB = VC when the deviation is a minimum, *i.e.* the deviation is a minimum when the course of the ray makes equal angles with the sides of the prism.

[Oxford men will remember that more than twenty years ago Prof. Clifton gave a somewhat similar proof as follows:—

Since the paths ABCD and D'C'BN are similar, if one is a path of minimum deviation the other must have the same property also. Hence, since light can always travel in the reverse direction along a path, the paths

ABCD and NBC'D'

are both paths of minimum deviation.

But the existence of two such minima is contrary to experiment. Hence the paths must be identical, which can only be the case of the angle VBC = VBC' = VCB.—ED.]

Further Notes on the Anatomy of the Heloderma.

SINCE I published in NATURE (vol. xliii. p. 514), "The Poison Apparatus of the Heloderma," there has appeared from the pen of Mr. Boulenger another notable contribution to the anatomy of that genus of reptiles, entitled "Notes on the Osteology of *Heloderma horridum* and *H. suspectum*, with Remarks on the Systematic Position of the *Helodermatidæ* and on the Vertebræ of the Lacertilia," (P.Z.S., January 20, 1891). That paper is especially useful, inasmuch as it critically compares the vertebral columns of the two species of Lizards under consideration—a comparison which, up to the time of the appearance of Mr. Boulenger's paper, had not been made. To briefly recapitulate his points, Boulenger finds differences in the form of the premaxillaries of the two species, and in the number of teeth supported by those bones. He finds palatine and pterygoid teeth constantly absent in *H. suspectum* but present in *H. horridum*—a very remarkable fact. A small azygous ossification was found in the cartilage of the mandibular symphysis of *H. horridum*, "apparently the homologue of the symphysial (mento-meckelian) bones of most tailless Batrachians." This

last discovery has important bearings in other directions. In the vertebral column there appear to be a total of 76 vertebræ in the case of *H. horridum* to but 63 or 65 in the spine of *H. suspectum*. And, in conclusion, this distinguished herpetologist remarks that "A short rib is present on the third cervical in *H. horridum*, which is absent in *H. suspectum;* the neural spines are more elevated in the middle and posterior portion of the dorsal region in *H. horridum*, specimens of the same sex, of course, being compared. The neural spines are much more developed in the male" (p. 116). Boulenger still thinks the place of the *Helodermatidæ* between the *Anguidæ* and the *Varanidæ*, which he assigned to them in 1884.

In concluding this notice I am led to pass some observations upon certain strictures Mr. Boulenger has made in his paper upon my memoir on the anatomy of *H. suspectum* which appeared in the Proc. of the Zool. Soc. of London for 1890. His criticism of my description of the atlas of *H. suspectum* is well taken, as I have satisfied myself of by an examination of better material since. That bone is found to be in *three* pieces, and not in *five* as stated by me. He is also quite correct when he comes to point out certain errors in my figures of *manus* and *pes* of that reptile, and I thank him for having called my attention to them. With respect, however, to the error he believes me to be guilty of in my description of the teeth in the premaxillary bones of *H. suspectum*, I can in no way agree with him. He observes: "Eight or nine præmaxillary teeth are present in *H. horridum*, and only six in *H. suspectum*. Dr. Shufeldt, however, represents eight teeth in the latter species; but his figure, showing all the teeth as of the same size, looks very diagrammatic." In his figures illustrating these remarks Mr. Boulenger gives *H. horridum* but *six* teeth, and *H. suspectum* but *four*, and the drawings of the bones look, indeed, very diagrammatic. I cannot conceive of any lizard normally having but "nine" teeth in its premaxillary bone; it should at least be an even number. Now the mounted specimen of *H. suspectum* in the collections of the U.S. National Museum, has *eight* teeth in its premaxillary, and it was from that specimen that I drew my figure which appeared in the Proceedings. Normally, that is the number, but those teeth are often broken out in the Heloderms, and they become irregular by subsequent growth. The outer ones are always the longer, when the skull is perfect. In so far as the *form* of the premaxillary is concerned, as touched upon by Mr. Boulenger, I believe no little allowance must be made for *individual variation*, which is often quite considerable among lizards as it is among Vertebrates higher in the scale. Other figures illustrating the work under consideration are excellent.

It would appear that it is to be the fate of the *Helodermatoidea* to have their morphology more thoroughly worked out than most, or even any other, lizards up to the present time; and I am given to understand that Prof. Garman, of Harvard College, has it in mind to review, in the near future, the entire structure of *H. suspectum*. R. W. SHUFELDT.

Smithsonian Institution, July 8.

THE DISCOVERY OF THE STANDARDS OF 1758.

THE discovery by the Clerk of the Journals of the House of Commons, referred to in NATURE last week (p. 280), of the original standards of length, which were in 1758 deposited in the custody of the Clerk of the House, has attracted some attention to the history of these Parliamentary standards. As some misapprehension as to the effect of such discovery appears to have arisen, and as it is to eminent men of science that we are mainly indebted for our standards of length, the following explanatory notes may interest many of our readers.

The standards of length above referred to were made under the directions of a Committee of the House of Commons, of which Lord Carysfort was Chairman, appointed on May 26, 1758, "to inquire into the original standards of weights and measures in this kingdom." The Committee reported that in 1742 several members of the Royal Society were at great pains in taking an exact measure of the ancient Exchequer standards of length (of Henry VII. and Queen Elizabeth), then condemned by the Committee as being coarsely made and "bad standards"; that such measure was made by "very curious instruments prepared by the late ingenious Mr. Graham"; and that the Royal Society had lent to the Committee a brass rod made pursuant to these experiments, which rod had been compared by Mr. Harris, of the Royal Mint, with the Exchequer standards. Mr. Harris advised the Committee that the Royal Society's standard was made so accurately, and by persons so skilful and exact, that he did not think it easy to obtain a better standard; and accordingly the Committee then had two rods made by Mr. Bird, an optician, according to Mr. Harris's proposal; which "rods" were laid before the House. The rod marked "Standard Yard, 1758," was to be taken as the proper standard; it was stated by the Committee to be made of brass, to be about 38 or 39 inches in length and about one inch thick; near to each end of the rod a fine point and line being drawn on a gold stud, the distance between the points on the gold studs being the "true standard length of a yard," or 36 inches. The second rod was made in the same manner as the first rod, excepting that it had "two upright cheeks" instead of points or lines; so that any other yard rod might be measured by being placed between the cheeks. Both these rods (together with three standard troy pounds marked "$\overset{\text{lb}}{\underset{1758}{\text{T}}}$," with a crown and "G.2," and a set of troy standards from 2 pounds to 32 pounds, made and adjusted by Mr. Harris "with very curious and exact scales of his at the Mint") were stated by the Committee to be then deposited with the Clerk of the House of Commons.

In 1838 the attention of the Government was directed to the necessity of determining a new standard weight and measure to replace the above standards of 1758, which were stated by the Chancellor of the Exchequer—in a letter to Mr. G. Airy, the Astronomer-Royal—to have been "destroyed by the burning of the Houses of Parliament," and a Commission was appointed to restore the standards. The Commission included F. Baily, J. E. D. Bethune, Davies Gilbert, J. S. Lefevre, J. W. Lubbock, Geo. Peacock, R. Sheepshanks, J. Herschel, and G. B. Airy. Their report of 1841 gives a precise description of the condition of the standards at the Journal Office immediately after the fire. The Committee reported that the legal standard of one yard was "so far injured that it was impossible to ascertain from it with the most moderate accuracy the statutable length of one yard"; and also that the "legal standard of one troy pound was missing." New Parliamentary standards of length and weight were accordingly made under the directions of the Committee, and were legalized by an Act of Parliament passed in 1855. These new Imperial standards are now deposited with the Board of Trade, but legal "Parliamentary copies" of them are stated to have been immured, in 1853, in the House of Commons, and further copies were then deposited at the Royal Mint, the Royal Observatory, and with the Royal Society. These latter Parliamentary copies are legally required to be compared with each other once in every ten years, but those deposited at the House of Commons are excepted from any such comparison. It would appear, however, that the House of Commons standards are sometimes examined, as is shown by some printed correspondence on this subject which was laid before the House of Lords in 1872, in which year the standards were examined, and after their examination were again immured in a wall near the lower waiting hall of the House of Commons; a certificate of the deposit of the standards being given as follows:—

"It is hereby certified that this day, in the presence of the undersigned, the oaken box containing the Parliamentary Copy No. 4 of the Imperial Standard Yard, and the Imperial Copy No. 4 of the Imperial Standard Pound," . . . has been "deposited within the wall on

the right-hand side of the second landing of the public staircase leading from the lower waiting hall up to the Commons Committee Rooms, a brass plate having been fixed upon the wall bearing the following inscription in Elizabethan or church text :—Within this wall are deposited standards of the British Yard Measure and the British Pound Weight, 1853." The certificate is signed by G. B. Airy (Astronomer-Royal), John George Shaw Lefevre (Clerk of the Parliaments), W. H. Miller, C. P. Fortescue (President of the Board of Trade), H. W. Chisholm, and H. J. Chaney; and is dated March 7, 1872.

It hardly appears, therefore, that the old standards of 1758, which appear to have remained unnoticed for the past fifty years, are now of any importance for the purposes of measurement.

MAXWELL'S ELECTRO-MAGNETIC THEORIES.[1]

AN account of Maxwell's electric theories from the pen of Prof. Poincaré could not but be full of interest. The volume before us is the first of two on the views and conclusions set forth in the "Electricity and Magnetism" regarding electro-static and electro-magnetic action, and their verification by Hertz and others; and we must of course wait for the completion of the work before we can form any adequate idea of its scope and character, and fully understand the results of the critical analysis which it contains. But in spite of the fact that the treatise is in the somewhat disadvantageous form of an edited course of lectures, it is a contribution of great value to the literature of the subject. Whether or not it is possible always to agree with the physical views expressed regarding matters which are not yet outside the region of speculation, it is impossible not to admire its style and methods. Here are to be found exemplified that order and harmony which render the work of the best French mathematical writers so exquisitely clear, and that artistic charm which is so seldom seen in the writings of scientific men of other nationalities. It has been remarked by competent critics that Maxwell's work, though essentially that of an artist and man of genius, is obscured here and there by a certain vagueness and want of logical coherence and completeness, which has tried the patience and strength of many a devoted disciple. This was of course to a great extent inevitable. He sought out new fields of speculation for himself, and his greatest and most successful generalizations were, one cannot help feeling, the results rather of unerring intuition than of any completely systematic process of reasoning. Those who follow in his footsteps therefore are glad of the help of any friendly guide who is able by his experience and strength to point out the dangers and diminish the difficulties which attend their progress.

In his introduction Prof. Poincaré gives a critical estimate of Maxwell's theories which strikes one at first sight as somewhat inappreciative. Thus he says :—

"La première fois qu'un lecteur français ouvre le livre de Maxwell, un sentiment de malaise, et souvent même de défiance se mêle d'abord à son admiration. Ce n'est qu'après un commerce prolongé et au prix de beaucoup d'efforts, que ce sentiment se dissipe. Quelques esprits éminents le conservent même toujours. . . . Ainsi en ouvrant Maxwell un Français s'attend à y trouver un ensemble théorique aussi logique et aussi précis que l'optique physique fondée sur l'hypothèse de l'éther; il se prépare ainsi une déception que je voudrais éviter au lecteur en l'avertissant tout de suite de ce qu'il doit chercher dans Maxwell et de ce qu'il n'y saurait trouver.

"Maxwell ne donne pas une explication mécanique de l'électricité et du magnétisme; il se borne à démontrer que cette explication est possible.

"Il montre également que les phénomènes optiques ne sont qu'un cas particulier des phénomènes électromagnétiques. De toute théorie de l'électricité on pourra donc déduire immédiatement une théorie de la lumière.

"La réciproque n'est malheureusement pas vraie; d'une explication complète de la lumière, il n'est pas toujours aisé de tirer une explication complète des phénomènes électriques."

The author, however, shows throughout his exposition that he is not only impressed with the extraordinary importance of Maxwell's work, but also thoroughly appreciates and admires, if occasionally under protest and with longing after the more ancient classic models, its somewhat wild and native beauty.

An important part of the introduction is an exposition of the theoretical basis of what Prof. Poincaré rightly regards as the fundamental idea of Maxwell's treatment of electro-magnetism—that is, the application of the general processes of dynamics to any system of current-carrying conductors. No doubt almost all the work which had been done previously had been more or less of this nature, but we refer here to the attempt which Maxwell made with very considerable success to correlate electro-magnetic phenomena by means of Lagrange's general dynamical equations.

In the Lagrangian method the physical state of a system is defined by means of certain parameters $q_1, q_2, \ldots q_n$, n in number; and a dynamical explanation is obtained, or proved to be possible, when the values of these parameters are found in terms of, or proved to be related to the positions and motions of a system of connected particles, either of ordinary matter, or of some hypothetical fluid.

If $m_1, m_2, \ldots m_p$ be the masses of these particles, x_i, y_i, z_i the Cartesian co-ordinates of the particle of mass m_i, and if the system have potential energy V, a function of the $3p$ co-ordinates of type x_i, y_i, z_i, there are $3p$ equations of motion of the form

$$\left.\begin{array}{c} m_i \ddot{x}_i + dV/dx_i = 0 \\ \text{\&c.} \qquad \text{\&c.} \end{array}\right\} \quad \ldots \ldots \quad (1)$$

The kinetic energy T is

$$\tfrac{1}{2}\Sigma m(\dot{x}^2 + \dot{y}^2 + \dot{z}^2),$$

and the principle of conservation of energy gives $T + V =$ constant.

Now we know V, and can express the co-ordinates of each particle or molecule in terms of the n parameters $q_1, q_2, \ldots q_n$. The celebrated Lagrangian equations in terms of the parameters can then be obtained by direct transformation of (1), and are of the type

$$\frac{d}{dt}\frac{\partial T}{\partial \dot{q}_k} - \frac{\partial T}{\partial q_k} + \frac{\partial}{\partial q_k} = 0.$$

Here T and V are homogeneous quadratic functions, the first of the quantities of type $\dot{q}$, with coefficients which are functions of the parameters themselves, the latter of the parameters only.

If we have reason to believe that the system we are dealing with is a dynamical system, for which the values of T and V (or, more properly, those parts of the total kinetic and potential energies which are concerned in the special phenomenon treated), can be obtained by observation of parameters of type q, we can use these equations in our discussions of results, whether or not we can actually express the parameters in terms of co-ordinates of particles of the system. The justification of this process is the agreement of the results with experiment.

If now we imagine a system of particles (whether of

[1] "Électricité et Optique." I. Les Théories de Maxwell et la Théorie Électromagnétique de la Lumière. Par H. Poincaré, Membre de l'Institut. (Paris: Georges Carré, 1890.)

actual or hypothetical matter) say p in number, which has the required values of T and V, and which further gives the same relations of the parameters q, we have obtained a dynamical explanation of the phenomenon. Prof. Poincaré remarks with respect to this process that no dynamical solution of the problem obtained in this way can be unique, and that in fact it must be possible to obtain in this way an infinite number of different solutions, or to quote his own words:—

"If any phenomenon admits of a complete mechanical explanation it will admit of an infinite number of others which equally well account for all the results of experiment."

This, as he reminds us, is confirmed by the history of physical inquiry. Theories inconsistent with one another are elaborated by different persons, and explain the known facts so well that there is hardly anything left to decide which is right. For example, according to Fresnel the direction of vibration in a ray of plane polarized light is perpendicular to the plane of polarization, according to Neumann and MacCullagh it is *in* the plane of polarization. It can hardly be said that any perfectly absolute *experimentum crucis* has yet been found to decide between these two theories, although the balance of evidence seems decidedly in favour of the view of Fresnel.

It is, however, to be remembered that while we can find different mechanical theories to explain the facts, the theories are not necessarily distinct; the mechanism proposed performs functions which must be performed by the actual mechanism whatever that may be. There always is, as the above cited case well illustrates, a unity connecting the different explanations and a consequent element of similarity among them; and each satisfactory theory elaborated must tend to progress by suggesting modes of deciding in what respects it is redundant or inadequate.

The difficulty then as to real mechanical explanations of phenomena does not prevent us from making progress in our knowledge of matter. The Lagrangian method, and this is its remarkable merit, enables us to use the parameters instead of the co-ordinates of actual particles, and thereby to predict the existence of further properties of matter capable of throwing light on those already observed. In this way may be lightened the task, happily not likely to be soon relinquished by the human intellect, of inquiring into the actual constitution of matter and the mutual actions of its parts.

There seems, however, no doubt that Prof. Poincaré is correct in his view that the central idea of Maxwell's treatise is to prove the existence of a mechanical explanation of electrical phenomena, not indeed actually finding it, but by showing that the Lagrangian method, which presupposes such an explanation, is applicable, and leads to consistent results.

Coming now to the detailed exposition of Maxwell's theories, the first thing that calls for notice is the theory of electric displacement. This has always been a subject of considerable difficulty. What is electricity? is it the ether or something in the ether? in what consists its displacement? are questions which the anxious inquirer is continually putting, and putting in vain. Maxwell's electric displacement and electric force remain simply analogues to the strain and stress in an elastic solid, and it can hardly be said that anyone has yet brought them out of the category of abstractions. No doubt the mechanical analogues suggested by Maxwell himself and by others are helpful in fixing the ideas and enabling the mind to form some concrete conception of what takes place in the medium; but they may easily be carried too far, and prove the means of leading to error. It is almost better in some respects to remain content, if possible, with abstractions, until further light as to the properties of the ether is obtained by experiment and observation; and perhaps it is on this account that Maxwell has abstained from giving such illustrations in his treatise. On the other hand, some notion corresponding to that of electric displacement is necessary for any theory of electrical action regarded as propagated through a medium surrounding the electrified bodies, whose charges become thus the surface manifestation of the state of constraint set up in the dielectric by the electrification.

Prof. Poincaré distinguishes between two fluids—one which he calls *electricity*, and the other the *fluide inducteur*. Both fluids are incompressible, the latter fills all dielectric space, the former is capable of being produced at or placed at any given place or on any given surface. If, then, within a closed space a quantity of electricity is introduced, as, for example, when a charge is placed on the surface of a conductor, an equal quantity of the *fluide inducteur* is forced out across the bounding surface. When all the conductors of a system are in the neutral state, the *fluide inducteur* is in normal equilibrium; when, on the other hand, the conductors are electrified, the equilibrium ceases to be normal and the state becomes one of constraint.

There is some advantage in thus distinguishing between the fluid constituting the electrification and that filling the surrounding space, as it avoids some difficulties of explanation and treatment which arise when only one fluid is considered as producing the phenomena.

After a rather lengthy but in many points critical exposition of the theory of dielectrics, founded on Poisson's notion of *couches de glissement*, we come to an interesting discussion of Maxwell's theory of stresses in a dielectric field. By a somewhat different process from that used by Maxwell, the stresses are found for an isotropic field to be a tension along and a pressure across the lines of force of numerical amount $KF^2/8\pi$, where K is the specific inductive capacity, and F is the electric force at the point considered.

On this result Prof. Poincaré remarks that, although it agrees very well with the observed attractions and repulsions between electrified bodies, yet if these attractions and repulsions are to be considered as due to the existence of such stresses in an elastic medium, the laws of elasticity for that medium must be very different from those for ordinary substances. The ideas of electric displacement and electromotive force at a point correspond to the strain and stress in an elastic solid; but, for correspondence to stresses of the value $F^2/8\pi$, it is necessary to find some different forms of displacement or strain than any that have yet been imagined.

A difficulty here arises to which Poincaré attaches considerable importance. The potential energy in the medium is, if f, g, h be the component electric displacements, given by the equation

$$W = \int \frac{2\pi}{K}(f^2 + g^2 + h^2)dv,$$

where dv is an element of volume and the integral is extended through all space. According to Maxwell's hypothesis as to the localization of the energy of the field, the amount contained in an element dv at which the displacements are f, g, h, is

$$\frac{2\pi}{K}(f^2 + g^2 + h^2)dv,$$

or $KF^2dv/8\pi$. Consequently, if F be increased to $F + dF$, there will be an increase in the potential energy of amount $2KFdFdv/8\pi$. If now the stresses act in the medium as ordinary stresses, they must produce corresponding strains in each element of volume. Hence if the element dv be a rectangular parallelepiped of edges δx, δy, δz when the field is free from electric stress, these dimensions will become, when an electromotive force F is produced at the element, respectively $\delta x(1 + e_1)$, $\delta y(1 + e_2)$, $\delta z(1 + e_3)$. Hence, if when F

is increased to $F + dF$, e_1, e_2, e_3 become $e_1 + de_1$, $e_2 + de_2$, $e_3 + de_3$, the work done by the stresses will, neglecting small quantities of the second order, be

$$\frac{KF^2}{8\pi}dv(de_1 - de_2 - de_3);$$

and if the increase of potential energy in the element take place in consequence of the work done against the stresses we get the equation

$$\frac{F^2}{8\pi}dv(de_1 - de_2 - de_3) = \frac{2FdF}{8\pi}dv,$$

or

$$de_1 - de_2 - de_3 = \frac{2dF}{F},$$

which gives by integration

$$e_1 - e_2 - e_3 = 2 \log F + \text{const.}$$

This result is inadmissible, since when F is zero, we must have $e_1 = e_2 = e_3 = 0$, while if this equation holds either e_2 or e_3 is infinite.

A solution of the difficulty is simply that the energy is not really potential but kinetic. It is certainly not easy to see why the electro-magnetic energy should be regarded as kinetic and the electro-static as potential, and it seems more natural to conclude, as all progress in knowledge of matter seems to indicate, that the properties of the medium are wholly due to motion.

After a short sketch of purely magnetic theory, Poincaré proceeds to what must be regarded as the most important part of his account of Maxwell's work—the theory of electro-magnetism. His investigation of the magnetic potentials of circuits is somewhat different from that usually given. Maxwell takes as his starting point here the equivalence of a current-carrying circuit of small dimensions and a magnet. Poincaré bases his method directly on the following three results of experiment: (1) that two parallel currents of equal intensity and of opposite directions in two close conductors exert no action on a magnetic pole at some distance; (2) if one of these currents have small sinuosities, its action on the magnetic pole is still equal and opposite to that of the straight current; and (3) that the magnetic action is proportional to the quantity of electricity which traverses a cross-section of the conductor in the unit of time.

With the assumption that the components of the force acting on a magnetic pole are obtained by partial differentiation of a function which depends only on the relative positions of the pole and the circuit, the usual theorems are obtained in the following elegant manner. First of all it is shown that the potential of a closed plane circuit at any point in its plane is zero. This is first proved for a circuit symmetrical about a line on its own plane and a point on the axis of symmetry. Then by using the first fundamental proposition to introduce across the circuit straight conductors each carrying two equal and opposite currents equal to the current in the circuit, a circuit of any form is divided into narrow portions each bounded at the ends by elements of the circuit, and at its sides by radial lines passing through the point in question. By using then the second proposition to replace each end-element of the circuit by a circular arc passing through the centre of the element and described from the given point as centre, each strip is turned into a complete circuit, symmetrical about a line through the given point. Since, then, the theorem is true for every such circuit, it is true for the whole given circuit which they build up. Next it is easily shown that when a circuit is situated on the surface of a cone but does not surround the axis—that is, is such that a generating line meets the circuit in an even number of points—the potential of the circuit at the vertex of the cone is zero. For, by means of conductors introduced along generating lines, and carrying equal and opposite currents as before, it is possible with the aid of the second result stated above to replace the circuit by a number of narrow plane circuits each carrying the given current, and symmetrical about a generating line of the cone. Hence each element produces zero potential at the vertex, and therefore so also does the given circuit.

Then it is proved that two circuits on the surface of a cone, each passing round the axis, produce equal and opposite potentials at the vertex, if the currents are equal and flow in opposite directions round the cone. For by means of hypothetical conductors introduced as before along the generating lines, and the second fundamental result, these circuits can be converted into narrow plane circuits, each carrying a current and symmetrical about a generating line. Thus the arrangement of two circuits produces no potential at the vertex. It is to be observed that the two circuits subtend equal solid angles at the vertex of the cone, and that the potentials must still be equal and opposite if the circuits surround distinct superposable cones.

Considering now any closed circuit, we can draw a cone from any chosen point as vertex, so that the generators pass through the circuit. Then this cone can be divided into an infinite number of infinitely small superposable cones of equal solid angle, each having a current flowing round it in the same direction as that round the given circuit, and the total potential at the common vertex is the sum of the equal potentials produced by three small circuits—that is, the potential is proportional to the solid angle subtended at the point by the circuit.

The equations connecting the components u, v, w, of currents with the components of magnetic force and magnetic induction, the relations connecting the magnetic force and magnetic induction, those connecting the magnetic force with the vector potential (which Poincaré calls the *moment électromagnétique*), and the value of the components of the latter quantity for a linear circuit with their application to the proof of Neumann's expression for the "electrodynamic potential" (the mutual intrinsic energy) of two linear current-carrying circuits, and the corresponding expressions for the "electrodynamic potentials" (electrokinetic energies) of the circuits themselves, are dealt with in the next two chapters.

In chapter ix. we come to the most important part of the book, the theory of induction, and the treatment of this part of the subject is instructive. It is a result of experiment that if the currents γ_1, γ_2, in two fixed circuits C_1, C_2, respectively, are varied, electromotive forces $Ad\gamma_1/dt + Bd\gamma_2/dt$, $Bd\gamma_1/dt + Cd\gamma_2/dt$ are produced, where B is a coefficient depending on the relative positions of the circuits, A a coefficient depending on C_1 alone, and C a coefficient depending on C_2 alone. Thus if the circuits are deformed or relatively displaced, electromotive forces of amounts $\gamma_1 dA/dt + \gamma_2 dB/dt$, $\gamma_1 dB/dt + \gamma_2 dC/dt$, are produced in C_1 and C_2, so that the total electromotive forces are respectively $d(A\gamma_1 + B\gamma_2)/dt$, and $d(B\gamma_1 + C\gamma_2)dt$. Now by the circuits, in which are supposed to act impressed electromotive forces E_1, E_2, the energy furnished in time dt is $E_1\gamma_1 dt + E_2\gamma_2 dt$. This must be expended in heating the conductors, and in doing *all* the work which is done in the displacement or deformation of the conductors. This latter work is of two parts, (1) that which is done in consequence of the geometrical alteration of the circuits, (2) that which is done in virtue of the change of the current strengths. But the "electrodynamic potential" of the system (Maxwell's electrokinetic energy) is

$$T = \tfrac{1}{2}(L_1\gamma_1^2 + 2M\gamma_1\gamma_2 + L_2\gamma_2^2),$$

so that the former work is

$$\partial T = \tfrac{1}{2}(\gamma_1^2 dL_1 + 2\gamma_1\gamma_2 dM + \gamma_2^2 dL_2).$$

Thus the work dW done in virtue of the changes of the currents is the difference between this and the excess of

the energy given out by the batteries over that spent in heat. Thus

$$dW = E_1\gamma_1 dt + E_2\gamma_2 dt - R_1\gamma_1^2 dt - R_2\gamma_2^2 dt - \partial T;$$

and this is the work done in virtue of changes of the currents. This quantity must be a perfect differential, since its integral vanishes for a closed cycle of changes. The condition which must hold for this enables the values of A, B, C to be identified with $-L_1$, $-M$, $-L_2$.

Maxwell's introduction of Lagrange's dynamical method into electro-magnetism is, as has been already stated, regarded by Poincaré as of great importance, and as he says "nous touchons ici à la vraie pensée de Maxwell." After finding by this method the inductive electromotive forces, and the electro-magnetic forces, he proceeds to discuss Maxwell's theorems of the electro-magnetic field, and their crowning generalization, the electro-magnetic theory of light. Except here and there, the treatment differs only in points of detail from that of Maxwell.

With regard to the equations of currents,

$$u = CP + \frac{K}{4\pi}\frac{\partial P}{\partial t},$$
$$\&c., \qquad \&c.,$$

a difficulty is pointed out as to the specific inductive capacity of a conducting substance. For such a substance the first term must preponderate, and so K must be small; whereas K is generally regarded as very great in the case of a conductor. It is worth noticing that this is really only a conventional means of explaining the impossibility of charging a condenser the space between the plates of which is filled with conducting substance; the true explanation is, no doubt, very different.

The discussion of the experimental verifications of the electro-magnetic theory of light contains references to several lately-established experimental facts (apart from Hertz's experiments, which are reserved for special treatment) which bear on the theory. For example, it has been shown by Curie that dielectrics, when tabulated in the order of increasing conductivity, are on the whole arranged (as obviously they should be) in the order of diminishing diathermancy. Further, ebonite, which is opaque to light, is very permeable to dark radiations of longer period, which agrees with its high transparency to electrical waves.

Again, it is remarked that the results of the electro-magnetic theory with regard to reflections from the surface of glass and of metals lend a general support to the theory, while the disagreement in the values of the numerical constants as regards the want of magnetic permeability is referred to the frequency of the vibrations and the fact that the magnetization of the medium is not instantaneously produced.

A marked feature of M. Poincaré's treatise is the chapter on rotatory polarization, in which he discusses the phenomena of rotation of the plane of polarized light by the action of a magnetic field. Although the essential difference between this effect and the apparently similar action of quartz, sugar solutions, &c., is pointed out, the author does not appear to lay stress on it as throwing light on the difference between their causes. For example, after giving Airy's differential equations, for the propagation of the two rectangular component displacements, ξ, η, of a circularly polarized wave travelling along the axis of z, in the form

$$\rho\frac{\partial^2\xi}{\partial t^2} = \frac{\partial^2\xi}{\partial z^2} + a\frac{\partial^3\eta}{\partial z^2\partial t},$$
$$\rho\frac{\partial^2\eta}{\partial t^2} = \frac{\partial^2\eta}{\partial z^2} - a\frac{\partial^3\xi}{\partial z^2\partial t},$$

from which a formula for the rotation of the plane of polarization of plane-polarized light in a magnetic field can be obtained, which agrees with experiment; and after comparing the results of these equations with those of other proposed equations, he says:—

"Mais si le concordance de la formule avec l'expérience justifie l'introduction des derivées $+\partial^3\eta/\partial z^2\partial t$, $-\partial^3\xi/\partial z^2\partial t$ dans les secondes membres des équations du mouvement d'une molécule d'éther, aucune considération théorique ne préside au choix de ces dérivées à l'exclusion des autres; on ne possédait donc pas encore de théorie de la polarisation rotatoire magnétique."

This certainly seems rather too strong a statement in the face of Thomson's dynamical theory outlined in his "Electrostatics and Magnetism," and further elaborated in Maxwell's treatise.

Thomson's views on this subject are of the most fundamental importance, as they point to motion of, or in, the medium occupying the magnetic field as the cause of the magneto-optic effect discovered by Faraday, and to a certain structure of the substance as producing the phenomena shown by quartz, syrup, &c. One of the most interesting passages of his lectures on molecular dynamics, delivered at Baltimore in 1885, is that in which he accounts for the observed results by the presence of rotating particles, "gyrostatic molecules," in the medium.

It is obviously suggested by the gyrostatic investigation that it ought to be possible to explain the magneto-optic rotation in the electro-magnetic theory of light as a consequence of the presence of small magnets embedded in the vibrating medium with their axes in the direction of the ray; and therefore producing a component of magnetization in that direction. It is stated by M. Poincaré that a theory of this kind has been proposed by M. Potier, and published in the *Comptes Rendus*. The theory itself is not given, but the differential equations obtained are quoted, and are of the required form, and lead to the known experimental result.[1]

Maxwell's molecular vortices theory is, however, given, and certain difficulties which it involves discussed. The theoretical results of Hall's experiment are also given in this connection, and Kerr's experiment proving the production of elliptic polarization by the reflection of plane-polarized light from the pole of a magnet is cited, but without any statement of the theory of the effect which has been worked out, principally by Fitzgerald. With regard to the explanation of the Hall effect by strain of the conducting film produced by the magnetic field, it has always seemed to me that it ought to be possible with proper appliances to decide the question, by experimenting with a sufficiently powerful and uniform magnetic field.

The work, it ought to be stated, concludes with an interesting chapter by the editor, M. Blondin, on experimental verifications of the theories of Maxwell. This comprises the chief determinations of specific inductive capacity, Kerr's classical researches, and lastly, the interesting investigation made by M. Röntgen of the electro-magnetic action of currents of displacement.

Of Prof. Poincaré's second treatise on the experiments of Hertz, &c., I hope shortly to give an account as a sequel to the present article.

A. GRAY.

THE ORIGIN OF THE FLORA OF GREENLAND.

HOW the present flora of Greenland originated, is a question of great interest to British botanists and geologists, for the answer will probably help to solve the difficult problem, What was the origin of the recent flora of Britain? The flora of Greenland is so poor in species and has been so well studied that its relationship to the floras of Europe and America ought not to admit of much

[1] M. Poincaré's reference has suggested to me a mode of investigating the action of these magnets on the electro-magnetic theory. This is discussed in a separate article, which contains for the sake of comparison an account of the gyrostatic theory.

debate; yet we find that an active discussion is now going on among Scandinavian botanists as to its eastern or western affinities. Sir J. D. Hooker, in his "Outlines of the Distribution of Arctic Plants,"[1] made a careful analysis of the species found in Greenland, and came to the conclusion that the relationship was more European than American, and this view seems to have been generally adopted by botanists. In a recent official report, contained in the valuable series of memoirs published by the Commission for the Exploration of Greenland,[2] Prof. E. Warming, however, has tried to show that the flora is American; and as this author has had access to fuller materials than were formerly available, his opinion will carry considerable weight. Prof. A. G. Nathorst, a botanist especially competent to speak on questions relating to the botany of the Arctic regions and on the relation of the recent Arctic flora to the Glacial epoch, objects altogether to Prof. Warming's conclusions, and, although dealing with the same materials, maintains the accuracy of the generally accepted view as to the European relationship of the vegetation.[3] He also critically examines the flora in a way that has never been done before, and points to its dependence on bygone conditions. To certain of Prof. Nathorst's observations and conclusions I should like to draw attention.

The principal result arrived at by Prof. Warming was that the boundary between the American and the European provinces is formed by the Denmark Strait (the strait between Greenland and America), and not by Davis Strait as botanists have generally thought. This conclusion Prof. Nathorst critically examines, and so many curious and suggestive facts relating to geographical distribution come out in this examination that I may be excused for referring to certain of them somewhat in detail. The flowering plants of Greenland include 386 species, none of which are confined to that country. Leaving out of account circumpolar forms, Prof. Warming finds in the list 36 characteristic western against 42 eastern species, but suggests that when the flora of Arctic America is better known the balance will probably be in favour of the western forms. Prof. Warming, however, includes among the eastern plants only those now living in Europe, the Asiatic-American species being classed as western on the ground that they must have entered Greenland from the west rather than from the east—a somewhat unsafe line of reasoning when we take into account former changes of climate and the local extinction of many plants.

Prof. Nathorst analyzes the list differently, and gives most suggestive tables and a map of the local distribution of the eastern and western plants in Greenland. From these we find that the coast nearest to Iceland contains European forms alone, the southern extremity contains European forms in a majority, while the part of the west coast nearest to America yields principally western species; but taking Greenland as a whole the flora is more European than American. Another curious fact noticed by Prof. Nathorst is that the American element of the flora of Greenland is not entirely cut off by the Denmark Strait, but extends eastward as far as Iceland.

Prof. Warming considers that the nucleus of the present flora of Greenland represents part of the original flora, which was able to live through the Glacial epoch on the non-glaciated areas; but Prof. Nathorst points out that the few non-glaciated mountain-tops must have been far too high for any phanerogams to exist on them, and all the lowlands were then covered with ice and snow. We must therefore consider that both eastern and western elements of the present flora of Greenland entered the country in post-glacial times. The tables of distribution show at what points a large number of the plants entered—they came from the nearest land, whether European or American. Whether in post-glacial times there was any complete land-connection between Greenland and either North America or Iceland is very doubtful, but the straits may well have been narrower. The ice-foot, also, which collects in winter beneath the sea-cliffs is placed in the best possible position to receive any seeds or masses of soil which may fall during the winter. This shore-ice is drifted away in the spring, and may easily discharge its burden on some far-distant shore uninjured, and the seeds just ready to germinate. Winds, migrating birds, and migrating mammals would all help to transport seeds across the straits.

Turning now to the British Isles, we know that a prolific temperate flora inhabited this country in pre-glacial times. We know also that this flora disappeared and was replaced by a thoroughly Arctic one, at least as far south as Norfolk, where its relics are found beneath the moraines. Then came a period when Britain north of the Thames was covered with ice and snow, and only an occasional hill-top—or "*nunatak*," as it would be called in Greenland—rose above. When the ice retreated, the Arctic phanerogams again spread over the country, for we find *Salix polaris*, *S. herbacea*, *S. reticulata*, *Betula nana*, and *Loiseleuria procumbens* in lacustrine deposits immediately above the boulder clay near Edinburgh; we have also a similar flora, with *Salix polaris*, *S. myrsinites*, and *Betula nana*, in Suffolk; and even in Devonshire the dwarf birch has been found. This stage, though its flora is still imperfectly known, apparently corresponds closely with the present condition of Greenland.

In Britain, however, we have now reached a later stage in the amelioration of the climate and re-settlement of the country, for the Arctic plants have either disappeared entirely or have retreated to our mountain-tops, and in their place on the lowlands we find a temperate flora now living. The British flora, like that of Greenland, varies according to the botanical character of the nearest land, though, as with Greenland, there is no reason, except the supposed impossibility of the migration of the animals and plants without a bridge, to imagine that during post-glacial times there has been any direct connection with the Continent, save perhaps at the Straits of Dover. The distribution of plants in Britain is so peculiar that I may be forgiven for pointing out to non-botanical readers that we have a southern flora opposite France, a Germanic flora on the east coast, a Lusitanian flora in the south-west, and on the extreme west there are two American plants unknown elsewhere in Europe. In the Britain of the present day I believe that we may study the re-peopling of a country over which everything has been exterminated; and until we have fuller direct evidence of the stages of the process, we may safely accept Greenland and Britain as illustrating the way in which Nature works to fill gaps in the fauna and flora, whether these are caused by changes of climate, by volcanic agency, or the submergence and reappearance of islands.

CLEMENT REID.

[1] Trans. Linn. Soc. vol. xxiii., pp. 251-348 (1861); partly reprinted (with additions) in the "Manual of the Natural History . . . of Greenland," &c. (1875).

[2] "Om Grønlands Vegetation: Meddelelser om Grønland," Part 12 (1888).

[3] *Engler's botanischen Jahrbüch*, 1891, p. 183.

THE SUN'S CORONA.

SOME little time ago Dr. Schaeberle, of the Lick Observatory, was good enough to send me the following letter:—

Allow me to call your special attention to a note of mine in the forthcoming number of the A.S.P. Publications, entitled "Some Physical Phenomena involved in the Mechanical Theory of the Corona." I wish to say that, as far as the connection of this theory with the sun-spot period is concerned, there was not, at any time, any effort on my part to make an agreement with other theories, but the conclusions reached are the legitimate and inevitable results of tracing certain observed phenomena to unexpected explanations. As you will see, the logical outcome

of the whole matter is that, unconsciously, I have actually furnished important evidence in favour of your meteoric hypothesis.

Sincerely yours,

J. M. SCHAEBERLE.

Some time after the arrival of the letter I received the number of the Publications of the Astronomical Society of the Pacific which contained the article referred to, which I have read with the greatest interest. It has been known for some time that Dr. Schaeberle has been able to reproduce the general appearance presented by the corona by means of mechanical contrivances, and that even the polar rays, which were such a noticeable feature of the eclipse of 1878, as I saw it at Separation, can be, in this way, satisfactorily accounted for.

The point of newest interest, however, is that referred to in Dr. Schaeberle's letter.

Assuming *eruptions* most active in the sun-spot zones, and an initial velocity of 380 miles a second, he obtains the following results:—

(1) All parts of a given unperturbed stream will be in a heliocentric latitude nearly equal to the latitude of the point of ejection.

(2) For a constant ejective force the periodic time t will be the same for all parts of the stream.

(3) The chance of collision of a returning with an outgoing stream varies inversely as the square of the distance of the point of collision from the sun.

(4) Near the sun, therefore, collisions must occur which tend to retard or stop the outgoing streams, resulting in a temporary increase in the heat of the combined colliding masses (causing a consequent increase in the brightness of the corona at such places, and at the same time rendering the coronal detail more confused). This heat will tend to be largely dissipated before such masses fall back into the sun, which they will then reach with comparatively small velocity and low temperature. Unretarded returning streams on striking the sun will tend to greatly raise the temperature at the points of impact: perturbed returning streams could, of course, strike all parts of the sun's surface. Unperturbed returning streams will always fall within the limits of the sun-spot zones.

(5) So long as the incoming streams are very numerous, the outgoing ones will, in a great measure, be stopped, so that, after the interval t, there will be comparatively few returning streams: a direct result of this state of things is to allow free passage for the outgoing streams, which, since there are now but few collisions, results in (1) an apparent diminution in the brightness of the corona, (2) more regular and sharply defined detail, and (3) in general a more uniformly illuminated solar surface might be expected, when there are but few or no returning streams. The periodic character of this intermittent motion can be well illustrated by means of a fine vertical jet of water. The vertical vibratory motion of a light ball, often to be seen in water fountains, is also a good illustration.

(6) If the ejective force is such as to make t about five years, a complete cycle of changes will take place in the time $2t$, and after the same manner as is observed in the sun-spot cycle. It is rather remarkable that the aphelion distance of the streams corresponding to this value of t is nearly the same as Jupiter's distance from the sun; so that the perturbations produced by this planet may have more to do with the regularity of the period than the assumed constant force of ejection. The initial velocity required to just carry a particle from the sun to Jupiter is but little less than a parabolic velocity. For an initial parabolic velocity, Saturn, alone considered, would, on the same hypothesis, cause a complete cycle of less marked changes in twenty years, Uranus in sixty years, and Neptune in one hundred and twenty years. The comparatively insignificant planets inside of the orbit of Jupiter would cause minor variations, corresponding to cycles, which, even for Mars, would be of less than two years' duration.

(7) The chance of the earth passing through one of these outgoing streams, which have a mean latitude of 15°, is less than it is for an incoming perturbed stream.

(8) A phenomenon similar to the observed zodiacal light would result from the projection of many such streams in space, and the observed extent of this light proves that the matter which causes this illumination extends to greater distances from the sun than the earth's distance.

It is evident from the foregoing that the complete statement which is to appear shortly will be looked forward to with interest.

For myself, I am glad to think that the views I put forward in the concluding chapter of my "Chemistry of the Sun" will now be looked at from a new point of view. Time will show what the "falls" which take the first place in my scheme, and the second in Dr. Schaeberle's, really are. Certainly I have seen no cause lately to alter the view I expressed in 1887, that the primary cause of solar disturbance is the *descent* of matter on to the photosphere.

J. NORMAN LOCKYER.

NOTES.

ON Monday the Prince of Wales presented the Albert Medal of the Society of Arts to Mr. W. H. Perkin, "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilization of large quantities of a previously worthless material"; and to Sir Frederick Abel, "in recognition of the manner in which he has promoted several important classes of the arts and manufactures by the application of chemical science, and especially by his researches in the manufacture of iron and steel, and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material and as Chemist of the War Department." The medal awarded to Mr. Perkin was for the year 1890; that to Sir Frederick Abel was for the present year.

WE are glad to hear that in consequence of the deputation which waited upon Sir Michael Hicks-Beach on June 5, the Board of Trade have registered the British Institute of Preventive Medicine as a limited liability company, with the omission of the word "limited."

IT seems as if the introduction of large engineering views may soon produce a very marked effect upon the future of Egypt. Mr. Willcocks, one of the Inspectors of Irrigation, has communicated an interesting letter to the *Times*, from which we select the following remarks on the engineering importance of Dongola:—"The summer supply of the Nile is lamentably deficient for the existing cotton and sugar-cane crops of Egypt, so that all extensions of these valuable crops are out of the question under existing conditions. The Nile Valley in Nubia is eminently suited for storage of water, but up to the present all projects for storing the muddy flood waters of the Nile below the junctions of the Blue Nile and the Atbara have been condemned, as the construction of solid dams would have resulted in the silting up of the reservoirs themselves. This difficulty has disappeared now that it has been discovered that open dams can be constructed which will allow the muddy flood waters to flow through, and store the clear winter supply for use in summer. The construction of these dams has been rendered possible by the great success of Stoney's patent roller-gates, which can be worked under heads of 70 feet of water on a scale sufficient to pass the full flood supply of the Nile. At any time now Egypt

can construct a reservoir in its own territory by building an open dam at the head of the Assouan Cataract. If, however, Egypt were allowed to occupy the Nile Valley as far as Dongola, the reach of the river above the Wady Halfa Cataract would provide the necessary reservoir, and the Philæ immersion difficulty would be at an end. So far the summer supply needed for Egypt proper. If the Soudan itself is to be developed, it will only be necessary to construct solid dams at the heads of the Ripon Falls and Fola Rapids, and thus secure the Victoria and Albert Nyanza Lakes as magnificent reservoirs. These reservoirs would not only secure Egypt and the Soudan from drought, but would also, if provided with open dams, secure Egypt from excessive floods. The White Nile as it leaves the two lakes is a clear stream, so that the silting up of the reservoirs would be out of the question, leaving alone their great size."

WE very cordially congratulate Sir G. B. Airy (the ex-Astronomer-Royal), on the completion of his ninetieth year. A distinguished company assembled at the White House, Greenwich Park, on Saturday last, in honour of the occasion.

PROF. ADALBERT KRUEGER, Director of the Observatory of Kiel, has been appointed Prof. Schönfeld's successor at Bonn.

DR. FELIX has been appointed professor in the University of Leipzig.

THE Council of the Yorkshire College, Leeds, have appointed Mr. V. Perronet Sells, New College, Oxford, to be Extension Lecturer in Science.

A PROJECT is in the air for the erection of an Observatory on Mont Blanc. M. Janssen made an appeal last year for support in this undertaking, and on Monday at the Academy of Sciences he announced that his appeal had been heard. He has obtained the support of M. Bischoffsheim, Prince Roland Bonaparte, Baron Alfred de Rothschild, member of the Academy of Fine Arts, and M. Eiffel.

THE annual meeting of the Institution of Mechanical Engineers was opened on Tuesday at Liverpool.

SANITARY science has, during the last month, lost one of its pioneers, in the person of Dr. John Sutherland, whose record of work in the domain of sanitation since 1848 has been of a marvellous character. In 1848 he entered the public service under the first Board of Health, and continued to be employed under the Home and Foreign Offices till the year 1855. During this time he conducted several special inquiries—notably one into the cholera epidemic of 1848–49, which is even now frequently referred to. He was the head of a commission sent to various foreign countries to inquire into the law and practice of burial. He represented the Foreign Office at the International Conference, held at Paris in 1851–52, for regulating quarantine law. In 1855 he was engaged at the Home Office in bringing into operation the Act for abolishing intramural interments, a task which he had undertaken at the request of Mr. Walpole. He was also doing duty in the reorganized General Board of Health, under the presidency of Sir Benjamin Hall, when, at the request of Lord Palmerston and Lord Panmure, he became the head of the commission sent out to inquire into the sanitary condition of our troops engaged in the Crimean War. He found in Miss Florence Nightingale a devoted coadjutor in regard to the hospitals. Dr. Sutherland took an active part in the preparation of the report of the Royal Commission (of which he was a member) on the sanitary state of the Army, dated 1858, and also of the report of the Royal Commission on the sanitary state of the Army in India, dated May 19, 1863. Both of these were of vast importance to the welfare of our soldiers, and most of the recommendations contained therein have been carried out. One of these was the appointment of the Barrack and Hospital Improvement Commission, with Mr. Sidney Herbert, M.P., as President, and Captain (now Sir Douglas) Galton, Dr. Burrell, of the Army Medical Department, and Dr. Sutherland as members. By this committee every barrack and hospital in the United Kingdom was visited, and its sanitary condition reported upon. Defects were brought to light and remedied, and the health of the troops consequently much improved. Subsequently Dr. Sutherland and Captain Galton visited and made similar reports on the Mediterranean Stations, which at that time included the Ionian Islands. All these reports were presented to Parliament, and a reference to them will show the vastness of the work undertaken. In 1862 the Barrack and Hospital Improvement Commission was reconstituted, and all sanitary reports were submitted to the committee and reviewed by them, and suggestions for improving Indian stations prepared. This continued up to the time of Dr. Sutherland's retirement, on June 30, 1888. In 1865 he again visited Gibraltar and Malta, and made an independent and special report on the outbreak of epidemic cholera at those places. In 1866, Dr. Sutherland, in conjunction with Mr. R. S. Ellis, of the Indian Civil Service, Dr. Joshua Paynter, of the Army Medical Department, and Major (now Lieutenant-General, C.B.) Ewart, R.E., visited Algeria, and reported on the causes of reduced mortality in the French army serving in that country, with a view to seeing what of the conditions in force there would be applicable to Her Majesty's troops serving in India and other warm climates. The value of the recommendations made by him and his colleagues will be better understood by a comparison between the vital statistics of the army prior to the time of the Crimean War and those of the present date than in any other way.

MR. WILLOUGHBY SMITH, who had played an important part in connection with submarine telegraphy, died on July 17. He was born in 1828, and in 1848 entered the service of the Gutta-Percha Company, and superintended the manufacture and laying of the first submarine cable. The *Times* gives the following account of his subsequent career. In 1864 the Gutta-Percha Company became merged in the Telegraph Construction and Maintenance Company, and Mr. Smith remained with the company as chief electrician and manager of the gutta-percha works until his retirement through failing health in 1887. In 1866 he was electrician-in-charge, being on board the *Great Eastern* during the laying of the first successful Atlantic cable, and the recovery and completion of the cable that had been lost the year before. Mr. Smith was President of the Institution of Electrical Engineers in 1883, before which Society, as well as before the Royal Institution, he read many interesting and valuable papers. Amongst these was one on his discovery of the effect of light on the electrical quality of selenium, and another on his researches in volta and magneto-electric induction.

MR. DANIEL MACKINTOSH, F.G.S., died at Birkenhead last week at an advanced age. He was the author of a work on "The Scenery and Geology of England and Wales," and his researches on certain traces of the glacial epoch were well known to geologists. In recognition of his services to geological science, the Geological Society presented him in 1886 with a grant from the Lyell Fund.

MR. EDWARD STANFORD has published a pamphlet on "The Spread of Influenza: its Supposed Relations to Atmospheric Conditions," by the Hon. R. Russell. The following are some of the author's conclusions as to the conditions which give rise to influenza, and permit it to be spread. Influenza is a disease caused by exceedingly minute microbes, arising from extensive areas of marsh or sodden land in Central Asia, China, or Siberian. The minuteness of the microbes or their spores is shown by their

easy transmissibility, and the large number of persons capable of being infected by a single case in a large room, most persons probably requiring many virulent organisms to be inhaled in a short time before the resistant power of the blood is overcome. This microbe, like that of cholera, multiplies with great rapidity, and probably soon produces sufficient poison to terminate its career in the body, but not before multitudes of spores or microbes have been given off by the breath. Given the original conditions of rainfall, soil, and high temperature, the certain result is the development of inconceiva ble multitudes of microbes and spores; one species of these is capable of planting itself and living in the tissue and blood of man, of which the temperature is probably near that to which it has been accustomed under the summer sun in wet and drying ground. The somewhat rare and occasional visitations of influenza may be due to at least two or three causes—first, the occurrence of unusual rainfall and favourable summers; second, the prevalence of air-currents from the drying area towards inhabited places; third, adequate communication between these infected places and the towns of Russia, whence progress is rapid towards Western Europe. The wind has no influence that can be verified in the transportation of influenza. As for the means of prevention, Mr. Russell thinks that measures of disinfection and isolation of the earliest cases, and rules at ports and landing places similar to those employed against cholera, would probably prove of the greatest service. Inland, every locality should isolate and disinfect its first cases.

PROF. LANGLEY, the Director of the Smithsonian Institution, is now in this country. *A propos* of his recent researches, referred to in our last number, we learn that Mr. Maxim is building a "flying machine," with which a series of experiments is contemplated; it is now being constructed at Crayford, and is nearly ready for launching. It will be propelled by a light screw making 2500 revolutions a minute. The motive power (it is reported) is supplied by a petroleum condensing engine weighing eighteen hundred pounds, and capable of raising a forty thousand pound load. The real suspending power will lie in an enormous kite measuring 110 feet long and 40 feet wide.

THE following passage occurs in the Report of the Medical Officer of Health of the parish of St. George, Hanover Square, for the five weeks ending July 4, 1891:—"I have calculated the death-rate of the parish for the past month on the census population of 1881, and not on that of 1891, for the following reasons:—The census population of the parish in 1871 was 89,758, and that in 1881 was 89,573; I have no reason to believe that there was any serious inaccuracy in either of these enumerations, so that the population of the parish was practically stationary during the ten years from 1871 to 1881. The enumerated population in 1891 was only 78,362, showing an apparent decrease of 11,211 (or one-eighth of the population) since 1881. I know of no reason whatever for any such decrease, and do not believe it has taken place. The census was taken of the persons sleeping in the parish on the night of Sunday, April 5, a day which had two serious disadvantages, the first being that it was a Sunday, a day on which many people in this parish are out of town, and the second that it was the Sunday after Easter, and that large numbers of people had not returned to town from their Easter holidays. *I therefore consider that the enumeration of the population of the parish this year is of no value for statistical purposes*, and in estimating the birth-rates and death-rates, shall continue to use the census population of 1881, until a fresh and more correct enumeration shall have been made, which will, I hope, be in 1896." This is rather serious. What have our census authorities to say on the matter?

AN earthquake was experienced at Evansville, Indiana, on the 26th inst. The shock was so great as to create a panic in several places of worship. Considerable damage was done to property. The direction of the oscillations was from north to south.

THE weather prospects in the North-West Provinces seem to be improving. Beneficial rains have commenced to fall, and a famine is therefore less probable than it was. The distress among the ryots is, however, great, and the Government of India has voted a grant of £10,000 for their relief. The following telegram was read by Sir J. Gorst, on Tuesday night, in the House of Commons:—"There is an improvement in agricultural prospects and development of monsoon season. There has been good general rainfall throughout the country, except in part of Madras, the Carnatic, and Upper Burmah, in consequence of which there is no present cause of anxiety in Northern India. Strong monsoon blowing West Coast. More rain imminent in Punjab and Rajpootana, where fodder famine has been arrested by rain. Crop operations in Northern India generally progressing satisfactorily, and there is no present cause for anxiety in North-West Provinces and Oude."

THE Technical Education Committee of the Kent County Council has placed £3000 at the disposal of the South-Eastern Counties Association for the Extension of University Teaching, for courses of lectures suited to agricultural and rural populations in small towns and villages throughout the country.

THE Accademia delle Scienze dell' Istituto di Bologna offers a gold medal of 1000 lire value (about £40), the Aldini Prize, "to the author of a memoir which, based on certain data of chemistry, or physics, or applied mechanics, shall indicate new and really practical systems or new apparatus for prevention or extinction of fires." The memoirs may be manuscripts in Italian, Latin, or French (with inclosed name and motto), or printed matter published between May 11, 1890, and May 10, 1892. In the latter case, the memoir may be in another language than those named, but an Italian translation must be added. The date-limit is May 10, 1892.

THE most recent addition to Prof. Flower's excellent series of specimens illustrative of zoological structure placed in the entrance-hall of the Natural History Museum is a set of nineteen dissections prepared by Mr. G. Ridewood to illustrate the variations in the deep plantar tendons of the bird's foot. With the help of these preparations, the student will have little difficulty in understanding the mysteries of the *flexor longus hallucis* and the *flexor perforans digitorum*, upon which two muscles, as has been shown by Sundeval, Garrod, and Forbes, so much depends in the classification of birds.

IT would seem that the present interest in agricultural instruction comes none too soon. The *Agricultural Gazette* of New South Wales gives an account of a new industry—the export of butter to this country, and adds that the Minister of Mines and Agriculture has approved of the establishment of a travelling dairy to impart instruction to the settlers in relation to it.

THE same number contains articles on the grasses and weeds of the colony, and notes on economic plants and weeds, besides information of what some people consider as of a more "practical" character, touching profitable cows and pigs.

THE utilization of waste products is the order of the day. An interesting article on this subject, in relation to breweries, in the *Brewers' Guardian*, calls attention to the utilization of the carbonic acid gas produced in the fermentation of sugar. "On an average, English beer may be considered to contain 5 per cent. of alcohol, and as, in the fermentation of sugar, the

weight of carbonic acid produced is almost the same as that of alcohol (the exact proportions being 48·9 of carbonic acid to 51·1 of alcohol), there must have been 500,000,000 pounds of carbonic acid produced in our breweries. The specific gravity of carbonic acid is 0·1524, and therefore a simple calculation shows that the above weight is equal to 25,000,000,000 gallons—a volume it is almost impossible to realize; such a volume would require a space one mile square and forty yards high to contain it. It is now proposed to utilize the greater portion of this large quantity of carbonic acid. The process by which this is to be done has been tried for some little time past in St. James's Gate (Guinness's) Brewery, Dublin; and Sir Charles A. Cameron has reported very favourably on it. The following are the conclusions at which he arrives after a most careful examination of the process:—(1) An immense quantity of carbonic acid is produced in breweries, and is at present wasted; (2) a large proportion of this gas could be condensed to liquid at a cost not exceeding ½d. per pound, but probably less than ¼d. per pound; (3) the process of liquefying the gas is successfully carried on at Guinness's Brewery, Dublin; (4) the liquefied gas prepared at Guinness's Brewery is perfectly free from any peculiarity of flavour or odour; (5) the carbonic acid produced at soda-water works costs about 4d. per pound; (6) it is safer, and in every way more desirable, to use in beverages carbonic acid derived from a food substance, such as grain, than from mineral sources; (7) the uses of liquid carbonic acid are numerous, important, and increasing."

Among the plants shown at the meeting of the Royal Botanic Society on Saturday last was a museum specimen of one which had lately died in the Gardens—a victim to the late severe winter. This was one of several specimens of the East Indian or white mangrove, *Avicennia nivea*, sent to the Gardens by the late Duke of Buckingham when Governor of Madras. For some years past these plants had flourished amazingly, thanks to the near approximation to their natural condition attained by keeping them in a very wet state and watering only with sea-water. Under these circumstances they threw up from the roots a number of offsets, or upright adventitious roots, of from 10 inches to 12 inches high, and half an inch thick. In a space of 2 feet square as many as eighty appeared, looking like so many rakes standing up out of the water, and keeping as near as possible the same height above the surface. The only explanation, so far, has been that offered by the Secretary, Mr. Sowerby. In its native state the trees form a fringe along the sea-shore and estuaries of great tropical rivers, lining the banks with a dense and impenetrable mass of vegetation, pushing itself further and further into the river or sea, and leaving behind the dry land it has reclaimed. In such a position these curious rootlets must be an immense advantage to the plant, enabling it to retain all the *débris* washed to the sides, and at the same time preventing the soil between the roots from being carried away by floods, &c. The plants of this species now growing in the Gardens are the only ones alive in this country.

A most interesting report of a journey taken along the frontier of the British Protectorate of Nyassaland by Mr. J. Buchanan, C.M.G., Acting Consul at Nyassa, appears in the *Kew Bulletin* for July.

From the *Meteorological Observations at Sydney* for January 1891, just received, we learn that the temperature was 2° higher, the humidity 2·4 less, and the rainfall 0·87 inch greater than that of the same month on an average of the preceding thirty-two years.

The Indian Government has just issued a "Contents and Index of the first twenty volumes of the Records of the Geological Survey of India, 1868-87." Considering the important work done by this Survey, the index will be of great value to geologists. It consists of 118 pages.

The pamphlet entitled "A Summary of the Darwinian Theory," which was noticed in a recent issue (July 16, p. 247), has been printed for private distribution. The author, Mr. Pascoe, will supply a copy to any person interested in the subject on application to him at 1 Burlington Road, W.

A new and cheaper edition of the translation of vol. i. of Weismann's "Essays upon Heredity and Kindred Biological Problems" is announced for immediate publication by the Clarendon Press; and we understand that vol. ii. is in the press, and will consist of four additional essays, and a preface by Prof. Weismann.

Petermann's Mitteilungen for July contains an article on Zante, with an original map, based on the English Admiralty chart, by Prof. Partsch.

An official notice has been issued concerning the charitable foundation instituted by the Sisters Froelich at Vienna for subsidizing persons distinguished in science, art, or literature. Pensions and donations are to be granted to duly approved applicants. Applications should be addressed to the Trustees (das Curatorium), and transmitted to the President's office of the Common Council of the City of Vienna (an das Präsidialbüreau des Wiener Gemeinderathes Neues Rathaus) before August 31, 1891, through the I. and K. Austro-Hungarian Embassy in London, 18 Belgrave Square, S.W., where particulars of the terms and conditions of the foundation deeds, &c., can be obtained.

Further details concerning the new volatile compound, iron carbonyl, $Fe(CO)_4$, are published by Messrs. Mond and Quincke in the current number of the *Berichte*. It appears that as early as November last year they succeeded in volatilizing small quantities of iron in a stream of carbon monoxide, and recovering it again in the form of a metallic mirror by passing the gaseous product through heated tube. The best results are given when the iron is obtained by reduction of ferrous oxalate in a stream of hydrogen at as low a temperature as possible, very little exceeding 400° C., and allowing to cool in the stream of hydrogen to 80°. When carbon monoxide is led over the finely divided iron thus obtained, the issuing vapours are found to colour a Bunsen burner pale yellow; and if they are passed through a glass tube heated to a temperature between 200° and 350°, a mirror of metallic iron is deposited. If the tube is heated to a temperature superior to 350°, instead of a mirror a black flocculent deposit is obtained, containing carbon in addition to iron. The metallic mirror dissolves readily in dilute acids, and the solutions give all the reactions of iron. A quantitative analysis was made of one such mirror, and yielded almost theoretical numbers for pure iron. The black flocculent deposit was found in two cases to contain 79·30 and 52·78 per cent. of carbon respectively. The reaction, however, proceeds only very slowly. To give some idea of this, Messrs. Mond and Quincke state that after six weeks continued treatment of twelve grams of iron with carbon monoxide only about two grams had been volatilized. As the action becomes very slight indeed after treatment for some hours, the operation was interrupted at the end of every five or six hours, and the iron reheated to 400° in a stream of hydrogen, after which the reaction proceeded again as at first. It is calculated that the average amount volatilized was about two cubic centimetres per litre of carbon monoxide. This great dilution has of course rendered it very difficult to ascertain the composition and properties of the substance. Its composition has, however, been determined by absorbing the vapour obtained during eight to sixteen hours in mineral oil of boiling-point 250°-300°, which after numerous experiments has been found to be the best solvent for it, and heating the solution thus obtained to 180°, when it becomes black owing to the separation of metallic iron, and carbon monoxide is evolved. Determinations of the amount of separated iron and

the volume of carbon monoxide obtained in five such experiments gave for the proportion of molecules of CO to one atom of iron the numbers 4·14, 4·03, 4·15, 4·26, and 4·04 respectively. Hence there can be very little doubt that the compound is represented by the formula $Fe(CO)_4$, analogous to the nickel compound obtained last year, $Ni(CO)_4$. As regards the relation of the compound to the processes of iron and cementation steel manufacture, the authors are of opinion that, although they have been unable to prepare it at temperatures between 150° and 750°, still it is quite possible that it may be momentarily formed at such temperatures, but again immediately dissociated.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. G. Stevenson Macfarlane; a White-fronted Capuchin (*Cebus albifrons*) from South America, presented by the Earl of Carnarvon; a Silver-backed Fox (*Canis chama* ♂) from South Africa, presented by Mr. Max Michaelis; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. J. Smalman Smith; two Rough Foxes (*Canis rudis*) from British Guiana, presented by Mr. G. H. Hawtayne, C.M.Z.S.; two Pennsylvanian Buzzards (*Buteo pennsylvanicus*) from North America, presented by Sir Walter Hely Hutchinson; a Barn Owl (*Strix flammea*), British, presented by Mr. E. Hart, F.Z.S.; a Tigrine Cat (*Felis tigrina*), two Spotted Cavies (*Cœlogenys paca*), a White-lipped Peccary (*Dicotyles labiatus*), a Red and Yellow Macaw (*Ara chloroptera*), a Blue and Yellow Macaw (*Ara ararauna*), two Orange-winged Amazons (*Chrysotis amazonica*), two West Indian Rails (*Aramides cayennensis*), a Martinique Gallinule (*Ionornis martinicus*) from South America, a Golden Agouti (*Dasyprocta aguti*), three Crested Curassows (*Crax alector*) from Guiana, a Hawk-headed Parrot (*Deroptyus accipitrinus*), a Common Trumpeter (*Psophia crepitans*) from Demerara, deposited; an Azara's Agouti (*Dasyprocta azaræ*) from South Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF SUN-SPOTS AND FACULÆ.—*Comptes rendus* for July 13 contains the results of observations of sun-spots and faculæ, made by M. Marchand, at Lyons Observatory, during the first six months of this year. The following table expresses, in millionths of the sun's visible hemisphere, the surface covered by spots and faculæ during this period.

1891.	Surface covered by spots.	Surface covered by faculæ.
January	385	12·5
February	503	20·7
March	265	15·9
April	726	25·4
May	670	22·1
June	968	29·7
Total	3517	126·3

These figures demonstrate the increase in solar activity which must have been noted by all observers. The total spotted area of 3517 millionths is made up by 65 groups. During the whole of 1890 the spotted area given by 43 groups was only 3760 millionths. Since the end of March not a single day has passed without a spot being seen on the sun. With regard to distribution, 40 groups have appeared in the northern hemisphere as against 25 in the south. These occurred most frequently between the latitudes ± 20° and ± 30°. At the same time 22 groups have had latitudes between 10° and 20° (with four groups below 15°), thus indicating an approach to the equator.

The measures of faculæ give similar results. The two zones from 20° to 30° are the richest, and those from 0° to 10° the poorest. The total numbers are sensibly the same in both hemispheres. There is, however, a slight superiority in relative number in the northern hemisphere, but less marked than during 1890. The total surface covered by faculæ in 1890 was 103·3 millionths of the sun's visible disk, so that the figures now given indicate a considerable augmentation. It is also worthy of note that the results obtained for spots and faculæ show a certain parallelism, secondary minima in March and in May occurring in each case.

STARS HAVING PECULIAR SPECTRA.—In a communication to *Astronomische Nachrichten*, No. 3049, Prof. Pickering notes that a Group II. star situated in Sagittarius (R.A. 19h. 51·8m., Decl. − 42° 7′, 1900), having exhibited bright hydrogen lines in its photographic spectrum, was suspected of the variability of which this appearance is a characteristic. Measures of photographs of the star taken on different dates proved that the supposition was a correct one, and indicated a variation between the magnitudes 9·1 and 13·1.

The photographic spectrum of the star S.D. − 12°·1172 (R.A. 5h. 22·9m., Decl. − 12° 46′), mag. 9·2, appears to be the same as that of a planetary nebula as regards the positions of lines, but it differs in the interesting fact that the H_β hydrogen line (F) is unusually strong in comparison with the nebula line at λ 500.

Two more stars having spectra mainly consisting of bright lines, like the three stars in Cygnus discovered by Wolf and Rayet, have been discovered. They are Cord. G. C., 15·934h. (R.A. 15h. 15·9m., Decl. −62° 20′, 1900), and a faint star in the position R.A. 13h. 36·3m., Decl. − 66° 55′ (1900). The number of stars of the Wolf-Rayet type is thus brought up to thirty-five.

THE INSTITUTION OF NAVAL ARCHITECTS

THE first London summer meeting of the Institution of Naval Architects was held on Thursday, Friday, and Saturday of last week. During the thirty-one years that the Institution has existed, it has only held five summer meetings. The first of these was in Glasgow, and was highly successful, but it was not followed by another summer meeting until the year 1886, when the attractions of the Liverpool Exhibition were sufficient to cause the Council to arrange a second meeting for that year in the second city of the kingdom. The Newcastle and Glasgow Exhibitions followed in the two succeeding years, and the members accordingly were summoned to the banks of the Tyne and Clyde. All these meetings were successful in every respect, not only in adding to the membership of the Institution, but in the valuable papers contributed to the Transactions, and the interest of the various excursions. In spite of this, no summer meeting was held either in 1889 or 1890, in which years there were but the single three days' meeting in the spring. That has been conclusively proved not to be sufficient time for the conduct of the business of the year; and at the last spring meeting it was announced that in future two meetings would be held every year—the first to be the usual spring meeting, which always takes place in London, and the second to be held in the summer, either in London or elsewhere. The success of the meeting just held strongly supports the wisdom of this decision.

There was naturally not so long a list of papers on the programme as there is at the spring meeting, for allowance had to be made for the excursions. With the latter we are compelled to deal very briefly on account of pressure on our space, and we will therefore say a few words upon them at once, before proceeding to notice the papers. On the first day, Thursday, the 23rd inst., the afternoon was devoted to the Royal Naval Exhibition, and in the evening there was a dinner, at which Lord Brassey presided, the absence of the President, Lord Ravensworth, being caused by a domestic sorrow. On the Friday afternoon the excursion was to the shipyard of Samuda Brothers, at Poplar, and to the Thames Ironworks at Blackwall. The P. and O. Company also gave a luncheon, in the Albert Docks, on board the *Carthage*. At Samudas' the two second-class cruisers H.M.SS. *Sappho* and *Scylla* are in course of construction, and give quite a welcome air of bustle and activity to the Poplar yard, not long since a scene of what many thought to be permanent stagnation. These ships are 3400 tons each, and 9000 indicated horse-power. A large amount of armour-plate bending and machinery is now going on in this yard, and the machine tools were examined with much interest by many of those members to whom such work was new. At the Thames Ironworks there are also two ships in progress for the Royal Navy. These are the cruisers *Grafton* and *Theseus*. The latter name brings up stirring memories of another noble ship built in years past at Blackwall. The new steel *Theseus* is,

however, a very different craft from Nelson's old flag-ship. She and her sister-vessel the *Grafton* are each of 7350 tons displacement, and have engines which will develop 12,000 indicated horse-power. Saturday was devoted wholly to a single excursion, the members travelling down to Chatham by train, and going over the Dockyard. Mr. Yarrow had kindly arranged to send one of his first-class torpedo boats down to Chatham, so that those who wished to return to London by water were enabled to do so. The three great engineering firms, Penns, Maudslays, and Humphrys, also threw open their works to the inspection of members during the meeting.

We will now proceed to deal briefly with the proceedings at the two morning sittings of Thursday and Friday, during which six papers were read and discussed, of which the following is a list:—Ships of war, by Sir Nathaniel Barnaby, K.C.B.; on the alterations in the types and proportions of mercantile vessels, together with recent improvements in their construction and depth of loading, as affecting their safety at sea, by B. Martell, Chief Surveyor of Lloyd's Register of Shipping; centre and wing ballast tank suctions in double-bottom vessels, by G. R. Brace; some notes on the history, progress, and recent practice in marine engineering, by A. J. Durston, Engineer-in-Chief to the Royal Navy; progress in engineering in the mercantile marine, by A. E. Seaton; on the weak points of steamers carrying oil in bulk, and the type which experience has shown most suitable for this purpose, by George Eldridge.

On the meeting being opened, Lord Ravensworth, the President of the Institution, who occupied the chair, proceeded to deliver a short address, and then presented the gold medal of the Institution to Prof. Lewes for his paper on "Boiler Deposits," read at the last meeting. The gold medal is not given to members of Council, so that some of the papers read at the spring meeting were out of the competition. Sir Nathaniel Barnaby's paper brought forward some of the most salient features in the history of war-ship design during the thirty-one years which have elapsed since the Institution was founded. An interesting fact noticed was that our earliest armour-clad, the *Warrior*, and our latest, the *Ramillies*, were of exactly the same length—380 feet. There, however, the likeness ends, for the modern ship is 14,150 tons displacement as compared with 9210 tons of the *Warrior*. Her horse-power is 13,000 indicated, the *Warrior's* being 5270; her speed is seventeen and a half knots against the *Warrior's* fourteen and a half knots; her armour is 18 inches thick, whilst the *Warrior's* was 4½ inches thick; her coal endurance is 5000 knots as against the *Warrior's* 1210 knots; her weight of broadside is 5500 pounds, as against the *Warrior's* 1918 pounds. These figures well illustrate the progress made in the science of war-ship construction, and the advance also extends to less desirable elements; for the cost of the hull and engines alone of the eight first-class battle-ships of the *Ramillies* class, now in course of completion, is £875,000 apiece, whilst the *Warrior* cost £357,000. It may be of interest to our readers if we add that the cost of a first-class battle-ship at the beginning of the century was about £70,000. The addition of machinery and other improvements brought the cost of the 121-gun screw three-deckers, which followed the Crimean War, up to close upon a quarter of a million. The armour alone of the *Ramillies* has cost exactly the same amount as the Natural History Museum at South Kensington. Bearing these facts in mind, it will be interesting to remember that Lord Brassey has laid down, in the programme of shipbuilding he would propose for the next five years, the number of first class battle-ships as ten; in addition to six armoured coast defence vessels, six armoured rams, forty cruisers of the first class, thirty look-out ships, and fifty torpedo gun-vessels. Nothing is said about the smaller torpedo *boats*, although a first-class torpedo boat costs nearly as much as a forty-gun frigate of Nelson's day. Some of our best naval authorities are, however, not so moderate as Lord Brassey; and Admiral Sir John Hay said, during the discussion on Sir Nathaniel Barnaby's paper, that he would have fourteen line-of-battle ships in place of Lord Brassey's ten. Vast as are the sums involved in the carrying out of such a programme as this, they are not so great, compared to the corresponding expenditure of foreign Powers in terms of the value of the commerce which the ships produced would have to protect. Admiral Sir Edward Freemantle, Lord Brassey, Sir John Hay, Mr. Wigham Richardson, the Director of Naval Construction (Mr. W. H. White), Sir Edward Reed, and others, spoke in the discussion, which was of a long and interesting description.

Mr. Martell's paper described the progress of that part of naval architectural design which bears more particularly on the construction of cargo steamers. The author traced the process of evolution by which the early steamers, naturally modelled after the sailing ships which they succeeded, gave place to later types, which in their turn were displaced by others found to be more suitable to the needs of the time. Mr. Martell dealt largely with the well-decked type upon which so many of the modern "ocean tramps" are modelled. The working of the Load-line Act was also considered by the author. One of the most interesting parts of the paper is the few paragraphs the author devotes to sailing ships. A few years ago it was freely prophesied that the days of masts and sails were past; that, so soon as the then existing vessels were worn out, wind-propelled craft would be confined to the yachtsman's sport. From the number of handsome sailing ships that were lying idle in nearly every port, the prognostication seemed warranted. Even the fishing boats seemed doomed by the multiplication of steam trawlers. Happily for the picturesque aspect of the mariner's craft, these forecasts have not been fulfilled. "Notwithstanding the great economy introduced by the triple-expansion engine," Mr. Martell tells us, "the tonnage of sailing vessels built has yet been well maintained in both 1889 and 1890." Vessels carrying 6000 tons of dead weight, with four masts, both ship and barque rigged, have recently been built; and arrangements have recently been made for the construction of a sailing ship, with five masts, to carry 7000 tons dead weight. This vessel is, however, to have a propelling engine fitted aft, but this engine is to be strictly auxiliary, to be used only in case of calms, and to enable the ship to dispense with the use of tugs. If such an arrangement can be conveniently made, and we see no insuperable difficulties, probably there will be a great future for vessels of this class pending the development of coal supplies in various parts of the world. Probably the boiler will take the form of some water tube type yet to be perfected, as quickness in raising steam is a great desideratum for such purposes. An elaborate table of vessels lost during the last ten years is added as an appendix to the paper. A short discussion followed the reading.

Mr. Brace's paper dealt exclusively with the detail of ship construction set forth in the title. As it took exception to Lloyd's rules, Mr. Martell naturally criticized it with considerable severity.

The sitting of Friday, the 24th inst., commenced with Mr. Durston's paper, which afforded a most interesting contribution to the history of the marine engine. The author takes the engine models in the Naval Exhibition for his text, and on them founds a monograph on the evolution of the marine engine as applied to war-ships from the days of the *Monkey*, the first steam-propelled vessel in the Navy. The *Monkey* was built at Rotherhithe in 1820, and was 210 tons. She was engined in the same year by Boulton and Watt with paddle-wheel engines of 80 nominal horse-power. It would take too much space to follow Mr. Durston in his description of the subsequent development of the branch of the naval service of which he is now the chief; and with which the names of Penn, Maudslay, Rennie, Seaward, Napier, Elder, and others are so intimately woven in the early, and most of them, happily, in later days. There is added to the paper a table giving particulars of 52 ships of the Royal Navy, commencing with the *Acheron*—having beam, paddle-wheel engines, and flue boilers, pressed to 4·5 pounds per square inch, the machinery being by Seaward—and coming down to the present day. The table is of the greatest value, and we cannot refrain from giving some details from it, even at the risk of extending this notice to undue length. The *Acheron*, of 293 actual horse-power, gave 2·2 units of power[1] per ton weight of machinery, the piston speed being 198 feet per minute. It required 10·74 cubic feet of boiler to give one indicated horse-power. The heating surface per indicated horse-power was 5·25 square feet, and the horse-power per square foot of grate was 3·1. The coal consumption is unknown. We will make a jump of 31 years, because that brings us to the first ship in the table of which the coal consumption is recorded. The ship we select is the *Hercules*, built in 1869, and engined by Penn with trunk engines of 8529 indicated horse-power, and, of course, a screw propeller. The boilers here were of the old rectangular or box tubular type, pressed to 30 pounds per square inch. The piston speed had then steadily risen in somewhat the same ratio as the boiler pressure, so that with the *Hercules* it had reached to the respectable figure 643 feet per minute. The indicated

[1] Unit of power = 1 indicated horse power.

horse-power per ton of machinery had also reached 7·5. The capacity of boilers per indicated horse-power was 2·17 cubic feet, the heating surface per indicated horse-power 2·6 square feet, the horse-power per square foot of grate 9·41 units, and the coal consumption per indicated horse-power per hour 2·811 pounds. Looking back over the twenty-two years that have elapsed since the *Hercules* was tried, and remembering the stringent and limiting conditions under which war-ship engines were then designed, one cannot but be struck by the remarkably successful results attained with the engines of the *Hercules*. No doubt this was due to the extraordinary pains taken in the design and manufacture of the engines of Her Majesty's ships in those days. The introduction of more complex machine tools in the workshop has enabled much of this minute care and finish to be dispensed with, and the advances in metallurgical science have put improved materials at the command of the engineer; but nothing has yet exceeded, or, we believe, ever will exceed, the beauty and accuracy of the noble examples of the mechanic's art constructed at the Greenwich shops under the direction of that prince of engineers, the late John Penn. At the same time we gladly acknowledge that the general average of all engines has immensely advanced, and is still advancing, both in design, material, and finish. The whole of these three qualities are due to a wider spread of that knowledge of scientific principles upon which the mechanical arts are founded. The manual skill of the handicraftsman has not increased; on the contrary, it has deteriorated as mechanical contrivances have superseded the old hand operations.

From this digression we will return to the table in Mr. Durston's paper, and take one more example. This shall be the *Royal Oak*, a sister of the *Ramillies* before mentioned, and one of the eight monster line-of-battle ships now in progress—the biggest war-ships ever yet designed. Laird Brothers, of Birkenhead, are the contractors for the *Royal Oak*. She has the vertical triple compound engines and ordinary return tube boilers of the present day. The indicated horse-power is put down at 13,000,[1] but will doubtless be much more, the steam pressure being 155 pounds per square inch, and the piston speed 918 feet per minute. The indicated horse-power per ton of machinery is 11·75 units, the capacity of boilers per indicated horse-power 1·06 cubic feet, the heating surface per indicated horse-power 1·55 square feet, and the horse-power per square foot of grate 18·31 units. The coal consumption remains, until the trials are made, a matter of conjecture, but there is every reason to anticipate it will approximate to that of the best performances recorded for Her Majesty's ships—namely, about 2 pounds of fuel per hour per indicated horse-power developed with natural draught. In taking this figure, however, we are somewhat unfair to the earlier engines, for we have taken the other performances of the *Royal Oak's* engines on forced draught, a condition under which the fuel consumption would be much higher. What may be the fuel consumption of Her Majesty's ships under forced draught we have no means of knowing. It should be remembered that, in the Royal Navy, the steam generated in the main boilers is used for the many auxiliary engines also, but the indicated horse-power of the main engines only is taken. This manifestly puts the engines of Her Majesty's ships at a considerable disadvantage in the matter of fuel economy when comparison is made with mercantile engines. If we had to summarize the lessons taught by Mr. Durston's tables in few words, we should say the stepping-stones to advance in marine engineering have been multi-tube boilers, compound surface-condensing engines, and forced draught. The latter is still in that state of popular disfavour which seems to be the natural condition of all innovations on established practice; but it will yet make its mark, and lead engine-designers to higher results, whilst it will drive them to more perfect work.

Mr. Seaton is well known as one of our best marine engineers, and is, moreover, a skilled writer, with a special talent for communicating his ideas through the medium of the pen. That is well proved by his contributions both in the shape of memoirs to technical Societies and also by his well-known work on the marine engine. Unfortunately for the literary side of his reputation he is the manager of one of the largest shipbuilding and engineering establishments in the country, and there are evidences of this in the paper he contributed to the meeting. It was intended to be a counterpart, from the mercantile point of view, of Mr. Durston's naval paper. Mr. Seaton was doubtless anxious to fulfil his promse to contribute to the proceedings, and has evidently done the best time would allow. His paper is a good illustration that "there is always plenty of room at the top," in the engineering, as in all other professions; but it does not call for any extended notice here. The same thing may be said of Mr. Eldridge's paper, which dealt minutely with technical details. It is, however, a distinctly valuable contribution to the Transactions of the Institution, and may be studied with advantage by all naval architects who may have to design steamers for carrying petroleum in bulk—vessels that are fast growing in importance and numbers.

The meeting terminated with the usual votes of thanks.

[1] The indicated horse-power of the *Sardegnea*, the big Italian war-vessel, is estimated to be 22,000. This is the largest power yet designed for any ship. There are four sets of engines, two for each propeller.

SEVENTH INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY.

THE arrangements for this Congress—which will be opened by the President, H.R.H. the Prince of Wales, on Monday, August 10, at the first general meeting at St. James's Hall, when short addresses will be given by some eminent foreign hygienists—are now in a very complete state.

We may mention that the previous Congresses were held in Brussels, Paris, Turin, Geneva, The Hague, and Vienna, at the last of which it was resolved, on the invitation of the Sanitary Institute and the Society of Medical Officers of Health, that the next Congress of the series should be held in London in the present year.

Besides the Permanent International Committee, to which a number of additional members have been attached for the purpose of this Congress, the executive consists of an Organizing Committee, with Sir Douglas Galton as Chairman; a Reception Committee, with Sir Spencer Wells as Chairman, and Mr. Malcolm Morris as Honorary Secretary; and a Finance Committee, with Surgeon-General Cornish as Chairman, and Dr. Moline as Secretary. There is also a numerous Indian Committee, with Mr. S. Digby as Honorary Secretary; and an Editing Committee. Prof. Corfield, whose address at The Hague Congress in 1884 was the origin of the present one (see NATURE, vol. xliii. p. 511) is the Honorary Foreign Secretary of the Congress, and Dr. G. V. Poore the Honorary Secretary-General.

The Congress is divided into nine Sections under Hygiene, and one under Demography, which includes Industrial Hygiene, and deals with the life conditions of communities from statistical points of view. The Hygienic Sections will meet in Burlington House and in the University of London. They are as follows:—

(1) Preventive Medicine. President, Sir Joseph Fayrer, K.C.S.I.

(2) Bacteriology. President, Sir Joseph Lister, Bart.

(3) The Relations of the Diseases of Animals to those of Man. President, Sir Nigel Kingscote, K.C.B.

(4) Infancy, Childhood, and School Life. President, Mr. J. R. Diggle, Chairman of the London School Board

(5) Chemistry and Physics in Relation to Hygiene. President, Sir Henry Roscoe, M.P.

(6) Architecture in Relation to Hygiene. President, Sir Arthur W. Blomfield.

(7) Engineering in Relation to Hygiene. President, Sir John Coode, K.C.M.G.

(8) Naval and Military Hygiene. President, Lord Wantage, K.C.B., V.C.

(9) State Hygiene. President, Lord Basing.

The Demographic Division will meet in the theatre of the Royal School of Mines in Jermyn Street, under the presidency of Mr. Francis Galton.

A large number of papers are promised, some on subjects selected by the officers of the Sections, and some on other subjects; indeed, there is such a profusion of papers that it seems very doubtful whether it will be possible to deal with them all during the four days available for the purpose, especially as we are informed that most if not all of the Sections will only sit from 10 a.m. to 2 p.m.

A vast number of delegates have been appointed from institutions and public bodies in this country. Delegates have been appointed by the Governments of all the European and several other countries, and also by many foreign Universities, cities, public institutions, and scientific societies. There are also a number of delegates from India and the colonies.

An Honorary Foreign Council, including the names of most of the best known foreign hygienists, has been appointed, and also an Honorary Council of the British Empire, with representatives from India and the colonies.

A Bacteriological Museum and Laboratory will be a special feature in connection with the work of the second Section; and an exhibition of drawings of sanitary construction, in connection with the work of the sixth Section, will be arranged in the Library of the University of London, under the direction of Mr. Thomas W. Cutler.

As is usual in gatherings of this kind, a considerable number of entertainments, excursions, &c., have been arranged for, including an entertainment at the Guildhall, *conversaziones* at the Royal Colleges of Physicians and of Surgeons, and a dinner and *fête* at the Crystal Palace.

A Ladies' Committee, under the presidency of Mrs. Priestley, has also been formed for the purpose of holding receptions and of organizing visits to various places of interest for the benefit of the ladies who may take this opportunity of visiting London.

A daily programme will be issued, giving the titles of the papers to be read, and the list of excursions, entertainments, &c., for each day; and besides this, *Public Health*, the journal of the Society of Medical Officers of Health (under the editorship of Mr. A. Wynter Blyth) will issue a special daily number during the Congress, giving abstracts of the more important papers in each Section.

A volume of abstracts of papers will also be issued, and a special hand-book for London is being prepared by Messrs. Cassell and Co. in French and English; this will contain several maps and plans, and will be mainly devoted to those matters which have a special interest for members of a Congress of Hygiene and Demography.

After the Congress a volume of Transactions will be published, to a copy of which each member will be entitled. The subscription is £1, and the offices are at 20 Hanover Square.

THE ORIGIN OF CERTAIN MARBLES.[1]

AMONGST the interesting collection of rocks brought home by Prof. Haddon from Torres Straits are some fragments of wind-blown coral-sand rock from Thursday Island. They have a deceptively oolitic appearance, and the majority of the grains being of a red colour give a prevailing warm tint to the stone, and thus render more conspicuous by contrast a number of dark green, worn, and rounded crystals of augite, which are scattered irregularly through it. The appearance of this handsome rock is sufficiently striking, but it gains greatly in interest from its suggestive resemblance to the famous Tiree marble, wherein likewise green grains of pyroxene are set in a flesh-coloured matrix of altered limestone. The comparison is confirmed and enhanced by an examination of thin slices; in the recent limestone the calcareous grains are found, as so commonly happens with these coral-sand rocks, to consist of rounded fragments of calcareous Algæ, and worn tests of various species of Foraminifera; mingled with these are more or less rounded crystals, not only of green augite, but also of olivine, felspar, and a finely crystalline glassy basalt; in the Tiree marble the green grains of pyroxene (salite) show beautifully rounded outlines, and are sharply separated from the surrounding matrix, into which they show no tendency to pass; crystals of felspar are also present—some fairly fresh, others, and these are the majority, corroded and almost entirely replaced by calcite, only the thin outer skin of the felspar preserving a fresh appearance; in some few cases, fragments of felspar partially penetrated by salite are met with. The calcareous matrix is finely granular, possibly dolomitic, but blotched and spotted by badly defined larger crystalline individuals of calcite, the outlines of which are sometimes obscurely rounded, so that although no trace of organic structure can now be recognized, yet on the whole the appearances are such as might be expected to be presented by a coral-sand rock, which had suffered metamorphic changes. Macculloch, in his detailed account of this rock, refers to its occurrence as an irregular mass, completely surrounded by gneiss; another white limestone occurs in the island, similarly disposed.

It is interesting to speculate on the final result of pressure metamorphism, acting on volcanic islands surrounded by their reefs. Thus, were the ancient granite masses of Queensland and New Guinea to approach one another, moving towards the line of weakness which now forms Torres Straits, we may conceive that basic schists in great variety would arise from the rolling out of the cores and superficial deposits of the intervening volcanoes; while the associated coral reefs would be converted into irregular masses of structureless limestone, and becoming involved in the surrounding schists would be irregularly dispersed through them, so as to occur in unexpected and anomalous positions.

In conclusion we would call attention to an important paper, read in 1876, by Mr. W. L. Green, Minister of Foreign Affairs to the King of the Sandwich Islands (footnote, Journ. Roy. Geol. Soc. Ireland, vol. iv. p. 140, 1877). *Inter alia*, he says:—

"The Hawaiian Islands are more or less surrounded by coral reefs, the island of Hawaii less so than the others, for one reason, because the lava has kept pouring into the sea along most parts of the coast during past centuries, and has not given the coral an opportunity to form to so large an extent as in the other islands. Now it is a fact that wherever the lava runs into the sea, or wherever the waves have an opportunity of breaking against [it], . . . a large quantity of olivine sand is formed. The felspar, the other material of which this lava is mainly composed, gets ground up to powder and disappears—indeed, it is almost always in the minutest grains to begin with; whilst the olivine, a much heavier mineral, and in grains from the size of a bean to a pea downwards, forms the main component of the sand of the sea-shore wherever the sea meets the lava, or else the olivine-sand gets more or less mixed up with the coral-sand, where the two classes of rock are in close proximity. A great deal of the olivine-sand is of the finest possible quality; indeed, it is often so fine that although a much heavier mineral than carbonate of lime, it will often, where both are washed by the waves, settle on the top of the coral-sand, and I have often scraped the almost pure fine olivine-sand from the top of a coral-sand beach. This mixture of the two sands is common over the group, extending 400 miles from Hawaii to Bird Island." Again, " . . . there is every grade of mixture from all coral to all olivine. Very often the olivine-sand rock will be found to run in streaks amongst the coral-sand rock, so that in the course of time, when the coral-sand rock comes to be metamorphosed into a limestone or a marble, the olivine-sand rock would probably suffer the change which that mineral is well known to experience—namely, into serpentine."

These views will certainly commend themselves to many of those who have come to regard Eozoon as a mineral structure. With the presumption in its calcareous composition of an organic origin, there has always existed a suspicion that some such explanation as this might eventually be found. It is interesting to note that the streakiness which Mr. Green expressly mentions as characterizing the interlamination of the olivine and coral sand, is so frequently an accompaniment of "Eozoonal" and serpentinous limestone.

[1] A Suggestion: by Profs. Sollas and Cole.

IS THE MARINER'S COMPASS A CHINESE INVENTION?

A WRITER in the *North China Herald* of Shanghai devotes a learned article to detailing and discussing the facts regarding the claim of the Chinese to have invented the mariner's compass. They did not learn the properties of the magnetized needle from any other country. They found it out for themselves, though it is impossible to point to the man by name who first observed that a magnetized needle points north and south. He suggests that it came about in this way. The Chinese have in their country boundless tracts of ironstone, and among these no small portion is magnetic. Every woman needs a needle, and iron early took the place of the old stone needles, and were commonly used before the time of Ch'in Shih-huang—that is, more than twenty-one centuries ago. Whenever a needle happened to be made of magnetic iron, it might reveal its quality by falling into a cup of water, when it happened to be attached to a splinter of wood, for example. It came in some such way to be known commonly that certain needles had this quality. The great producing centre for magnetic iron is T'szchou, in Southern Chihli. This city was very early called the City of Mercy, and the magnetic stone produced there came to be known as the stone of T'szchou, and so *t'szshih* became the ordinary name for a magnet. Later, the Chinese began to speak of the City as the "City of the Magnet," instead of calling it the "City of

Mercy." The polarity of the magnetic needle would become known to the Chinese of that city and its neighbourhood first. The first who noticed the polarity would be some intelligent person who communicated the fact as an unaccountable peculiarity in an age when omens and portents were diligently sought for in every natural object and phenomenon.

The earliest author who mentions the "south-pointing needle" lived in the fourth century B.C. There can be no reasonable doubt that the polarity of the needle was known at that time. The discovery of the fact must have preceded the invention of any myth embracing it. As to the discovery, there is no reason to suppose it was in any way foreign, because the Chinese use an enormous number of needles, and have an inexhaustible supply of ironstone. But though the polarity was known, it was not turned to a practical use till the Tsin dynasty, when landscapes began to be studied by the professors of *fengshui*, or geomancy. There was at that time a general belief in the magical powers of natural objects. This was a Buddhist doctrine, and it took firm hold on the Chinese mind of that age. The Chinese philosophers of those times taught that indications of good and ill luck are to be seen all through Nature. The polarity of the needle would take its place in this category of thought. Though it is not distinctly mentioned by writers of the fourth century, yet to their disciples it became an essential part of the landscape compass which the professors of *fengshui* all use. Kwo Pu, the founder of this system, died A.D. 324, and it was not till four centuries later that the *fengshui* compass began to assume its present form. The compass used by the professors of geomancy for marking landscape indications was first made about the eighth century. It was of hard wood about a foot wide, and it had in the centre a small well in which a magnetized needle floated on water. On the compass were inscribed several concentric circles, as on the wooden horizon of our globes. They embrace the twelve double hours, the ten denary symbols, eight diagrams, and other marks. This compass was used in preparing a geomantic report of any spot where a house or tomb was to be constructed, so that the construction might not be upon an unlucky site or planned in an unlucky manner. At the same time there was living a Chinese who had studied Hindoo astronomy, and was the Imperial astronomer, and also a Buddhist priest. He noticed that the needle did not point exactly north, and that there was a variation of 2° 95′. This variation went on increasing till a century later—that is, till the ninth century. A professor of geomancy then added a new circle to the compass. On this improved compass the first of the twelve hours begins on the new circle at 7½° east of north.

The compass, it will be observed, grew out of the old astrological report or nativity paper, calculated from the position of the stars, and prepared in the Han dynasty by astrologers as a regular part of social life, especially when marriages were about to be solemnized. Some of the old astronomical circles are preserved in the new geomantic chart. This was the compass used when Shen-kwa wrote on the south-pointing needle in the eleventh century. This author mentions that any iron needle acquires polarity by rubbing it on a piece of loadstone. He alludes to the variation as a fact which he himself had observed, and speaks of the south-pointing needle as an implement used by the professors of geomancy. By them it was employed in the form of a float upon water. After this, in 1122, an ambassador to Corea describes the use of the floating needle on board ship while he made the voyage. This is the first instance, the earliest by more than a century, of the use of the mariner's compass on board ship, found as yet in any book, native or foreign. The existence of the book in which this is recorded settles the question of the first use of the mariner's compass at sea in favour of the Chinese. At that time the needle floated on water supported on a piece of wood, but in the Ming dynasty some Japanese junks engaged in piracy were captured by the Chinese, and the compass in use on board was found to have the needle dry and raised on a pivot, while still pointing southward. The Japanese had learned from the Portuguese navigators to make a compass of this kind, and probably the needles they used were brought from Europe. From this time, the Chinese adopted the principle of a pivot, and made their compasses without a well of water in the middle to float the needle in. Charts were probably used of a very rough kind, but how far is not known. What is known is that the junk-master was aware of the direction in which the needle must point to reach the port to which he was going. In the Sung dynasty, embracing part of the tenth, as well as the eleventh, twelfth, and part of the thirteenth centuries, Chinese junks went to Persia and India. The Arabs trading to China directly would learn at that time the use of the compass, and would apply it on board their dhows. From them the Europeans learned this useful invention.

The credit of the discovery, both of the polarity of a magnetized needle and its suitability for use by mariners at sea must therefore, according to this writer, be given to the Chinese. It was China also that has the credit of having first noticed that any iron needle may be polarized by rubbing it with a magnet. In the thirteenth century the Arabs used a floating compass on their dhows. The needle was made to float on the water by attaching it crosswise to a cornstick or splinter of wood. A magnet applied to it drew it into a north and south direction. They would use Western notation to mark the quarters and intermediate points on the horizon. When therefore the mariner's compass was adopted from them, the Chinese 24 points were not communicated. In the European compass the notation of 32 points is Western, and rests on the winds and the sun. In the Chinese primitive mariner's compass the notation is that of the professors of geomancy, and rests on the old astrological division of the horizon into twelve double hours. From the Arab account we learn, what the Chinese accounts do not tell us, that the Chinese floated the needle by inserting it in a splinter of wood.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ROYAL COLLEGE OF SCIENCE.—The following scholarships, prizes, and Associateships have been awarded for the session 1890-91 :—First year's scholarships to William Allan, Thomas T. Bedford, Edwin Edser, and Herbert A. Clark ; second year's scholarships to John W. Pickles and Sydney Whalley ; the Edward Forbes Medal and prize of books for biology to Arthur G. Butler ; the Murchison Medal and prize of books for geology to Charles G. Cullis ; a Tyndall prize of books for physics, Course I., to William Allan ; the De la Beche Medal for mining to James G. Lawn ; the Bessemer Medal and prize of books for metallurgy to Joseph Jefferson ; the Frank Hatton prizes of books for chemistry to Herbert Grime and Lionel M. Jones. Prizes of books have been given by the Department of Science and Art in the following subjects :—Mechanics—Charles H. Kilby, Charles P. Butler, Herbert A. Clark. Astronomical Physics—Lawrence Parry and Samuel S. Richardson. Practical Chemistry—William A. C. Rogers. Mining—James G. Lawn. Principles of Agriculture and Agricultural Chemistry—Henry Wilkinson. Associateships of the Royal College of Science have been awarded as follows :—Mechanics—1st class, Harold Busbridge and Ernest W. Rees ; 2nd class, Angus Leitch. Physics—1st class, Sidney Wood ; 2nd class, William Shackleton and Alfred B. Lishman. Chemistry—1st class, Herbert Grime, Lionel M. Jones, Alfred Greeves, William A. C. Rogers, and Morton Ware ; 2nd class, John G. Saltmarsh. Biology (Zoology)—1st class, Arthur G. Butler and James Harrison. Geology—1st class, William J. Smeeth. The following Associateships, Royal School of Mines, have also been awarded :—Metallurgy—1st class, Joseph Jefferson, Alfred Stansfield, John Eustice, and William F. P. Tindall ; 2nd class, John D. Crabtree, Thomas S. Fraser, Henry T. Bolton, Benjamin Young, Hugh F. Kirkpatrick-Picard, George J. Snelus, James R. Crum, and Stanley H. Ford. Mining—1st class, James G. Lawn, John Yates, Robert Pill, Theodore G. Chambers, Algernon P. Del Mar, Nono Kitto, and George R. Thompson ; 2nd class, Reginald Pawle, Charles C. Scott, Henry Cavendish, Gustave Busch, George H. Gough, and Ben Howe.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for June contains :—An account of the meeting of the New England Meteorological Society on April 18 last. The subject of discussion was weather predicting. The general methods of predicting in the United States and Europe were first described, and afterwards local and long-range predictions were considered. Papers were read by J. Warren Smith, on the Signal Service weather forecasts ; W. M. Davis, on European weather predictions ; A. L. Rotch, on

the local weather predictions of the Blue Hill Observatory; M. W. Harrington, on weather prediction in the States and its improvement, together with several other similar papers.—The zodiacal light as related to the aurora, by O. T. Sherman. The author gives tables and curves constructed from a large number of observations, showing (1) the relative elongation of the zodiacal light, from observations taken in March, from 1801–86; (2) corrections to the earth's calculated longitude, being that part of the amount by which the observed position varied from the calculated, which is probably due to zodiacal light; (3) Fritz's auroral numbers for Europe south of the polar circle; and (4) his relative numbers for Europe. The conclusions drawn from the tables are that from 1806–27 there was no observation of the zodiacal light, slight and irregular variation of the earth's motion, and slight and irregular auroras. For the next fifty years each period of elongation of the zodiacal light corresponded with a maximum acceleration of the earth's motion, and a minimum in the aurora. And further, that at the time when the zodiacal light was beyond the earth's orbit, the auroras were few and diminished in number.—Farwell's rainfall scheme. This article (which is unsigned) states that Senator Farwell carried a Bill through the last session of Congress, for testing the possibility of the artificial production of rain by means of explosions. The experiments, which are soon to be tried, are intrusted to the Agricultural Department; the officials, however, are said to have little confidence in the success of the experiment. Mr. Fernow, Chief of the Division of Forestry, gives a long report upon the proposal, together with a summary of the literature of the subject.

American Journal of Science, July.—The solar corona, an instance of the Newtonian potential function in the case of repulsion, by Prof. Frank H. Bigelow. This is a continuation of the author's researches into the laws which regulate the development of the various coronal forms.—Newtonite and rectorite, two new minerals of the kaolinite group, by R. N. Brackett and J. Francis Williams. Taking the composition of kaolin as $Al_2O_3,2SiO_2,2H_2O$, the following series of hydrous silicates of alumina may be derived by eliminating or introducing a molecule of water:—

	Percentage Composition.		
	Al_2O_3	SiO_2	H_2O
(1) Al_2O_3, $2SiO_2$, H_2O ...	42·52 ...	49·99 ...	7·49
(2) Al_2O_3, $2SiO_2$, $2H_2O$ ...	39·57 ...	46·56 ...	13·93
(3) Al_2O_3, $2SiO_2$, $3H_2O$ ...	36·98 ...	43·47 ...	19·55
(4) Al_2O_3, $2SiO_2$, $4H_2O$ ...	34·72 ...	40·82 ...	24·46

From the facts and considerations stated in the present paper it appears probable that three members are known out of the four in the above series, viz. (1) rectorite, (2) kaolin and members of the kaolinite group, and (4) newtonite.—On the intensity of sound; ii. the energy used by organ-pipes, by Charles K. Wead. From the results of experiments with different organ-stops out, it appears that no exact conclusion can be drawn from the loudness of the sound as to the relative quantity of wind required to blow pipes of different construction; thus, the soft Dulciana stop of the organ upon which the experiments were performed took more than half as much wind as the comparatively loud Open Diapason, whilst the pipes of the Trumpet stop required less energy than any others sounding the same note. The results obtained in the case of different pipes of the same stop indicate that the volume of air used per second, and therefore the energy expended per second, varies as the $\frac{3}{4}$-power of the wave-length of the note, or inversely as the $\frac{3}{4}$-power of the vibration-ratio.—New analyses of astrophyllite and tscheffkinite, by L. E. Eakins. The analyses give $R''_4R'_4Si(SiO_4)_4$ as the general formula for astrophyllite. This agrees with that found by Brögger from a discussion of analyses by Bäckström and König. Tscheffkinite does not appear to be a mineral in any strict construction of the word, but merely a mixture.—The minerals in hollow spherulites of rhyolite from Glade Creek, Wyoming, by J. P. Iddings and S. L. Penfield. The authors find that in the rhyolite investigated fayalite occurs in association with abundant quartz of a peculiar development, as the result of the mineralizing action of vapours in the cooling acid lava. In certain hollow spherulites the fayalite is replaced by hornblende and biotite.—Bernardinite: is it a mineral or a fungus?, by Joseph Stanley Brown. From Mr. Brown's examination it appears that the mineral resin from San Bernardino County, California, described by Prof. Stillman in the *American Journal* twelve years ago, is the fungus *Polyporus officinalis*, Fries.—Development of Bilobites, by Dr. Charles E. Beecher.—Gmelinite from Nova Scotia, by Louis V. Pirsson. The optical characters, cleavage, and chemical composition of this mineral have been studied. The result of the crystallographic work points to a distinct difference between it and chabazite, but with regard to twinning and chemical constitution the two appear to be identical. Indeed, gmelinite seems to bear much the same relation to chabazite that enstatite does to hypersthene.—Analyses of *kamacite*, *tænite*, and plessite from the Welland meteoric iron, by John M. Davidson. The conclusion is arrived at that in the Welland siderolite only two distinct nickel-iron alloys occur, viz. *kamacite* and *tænite*, and that the so-called plessite is merely thin alternating lamellæ of the two.

American Journal of Mathematics, vol. xiii., No. 4.—In this number J. Perrott's "Remarque au sujet du théorème d'Euclide sur l'infinité du nombre des nombres premiers" is continued from No. 3, and concluded; the author promising a further article on "L'application du procédé du géomètre grec à d'autres cas de la proposition de Lejeune Dirichlet."—The following papers also appear:—Ether squirts, by Karl Pearson, an attempt to specialize the form of ether motion which forms an atom. The main portion of the paper is devoted to an investigation of inter-atomic and inter-molecular forces.—On the matrix which represents a vector, by C. H. Chapman. The fundamental idea is that the linear and vector function of a vector is simply the matrix of the third order.—Sur une forme nouvelle de l'équation modulaire du huitième dégré, par F. Brioschi.—The index to vol. xiii. is appended to this number, which concludes it.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 6.—The Hon. Lord McLaren, Vice-President, in the chair.—Mr. John Aitken read a paper on the solid and liquid particles in clouds (see p. 279, July 23).—Prof. Tait communicated a paper by Prof. Chrystal on a demonstration of Lagrange's rule for the solution of the linear partial differential equation, with some historical remarks on defective demonstrations hitherto current. Prof. Chrystal's proof is purely analytical. Prof. Tait remarked that, on quaternionic principles, the problem may be regarded as follows. Let the equation be

$$Pp + Qq = R,$$

where P, Q, and R, are given functions of x, y, and z, and p, q, represent respectively the quantities dz/dx, dz/dy. By the introduction of a new variable, u, this may be put into the form

$$P\frac{du}{dx} + Q\frac{du}{dy} + R\frac{du}{dz} = 0.$$

But du/dx, du/dy, du/dz, are proportional to the direction cosines of the normal to the surface $u = c$, and therefore P, Q, R are proportional to the direction cosines of a tangent line to $u = c$. Hence we deduce, as the equations of a curve which lies wholly on the surface,

$$\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}.$$

The integrals of these equations are known to have the form $v = \alpha$, $w = \beta$, where α and β are arbitrary constants. The intersections of these surfaces fill space with a set of lines, and the problem is to find a single general set of surfaces upon which these lines will lie. Their equation is $v = f(w)$, where f is an arbitrary function. It is therefore the integral of the given differential equation.—Prof. Tait read the fifth part of his paper on the foundations of the kinetic theory of gases. He has applied his expression for the isothermals of a liquid and its vapour to the case of ethyl oxide. The results are in remarkable accordance with the direct observations of Drs. Ramsay and Young. He has also applied the virial method to systems of doublets, triplets, &c. The close correspondence of the results calculated from his formula with Andrews's and Amagat's observations on carbonic acid was somewhat surprising when it was considered that the theoretical results were deduced on the assumption of smooth, hard, spherical molecules, while the molecule of carbonic acid is very complex. In the present part of his paper, Prof. Tait shows that, from the manner in which the (approximate) virial equation is formed, no term depending on internal actions in molecules themselves can appear in it when the number of molecules is sufficiently large. He also discusses the mechanism of equilibrium between liquid and

saturated vapour. He has reduced the difficulties of the problem to the evaluation of certain definite integrals.—Dr. John Murray communicated a paper by Mr. J. W. Gregory, of the British Museum, on the Maltese fossil Echinoidea, and their evidence on the correlation of the Maltese rocks. In this paper the fossil Echinoidea of Malta are revised, and many additions to the fauna made by the description of material recently collected. Several genera new to Malta are recorded, and also some species previously known only in Italy. Some changes in nomenclature are advocated: thus, as the author accepts the zoological use of the generic name *Echinanthus*, a new one—*Breynella*—is proposed for the genus known to palæontologists by the former term. In regard to the age of the Maltese beds, the author agrees with Fuchs as to the Lower Coralline limestone being clearly Oligocene; the overlying Globigerina limestone is assigned partly to the Aquitanian and partly to the Langhien: as no sharp line of division can be drawn between these two series, the exact limits of the Oligocene and the Miocene in Malta cannot be precisely determined. The blue clay appears also to belong to the Langhien, and to be hardly entitled to separation from the underlying Globigerina limestone; the greensand is referred to the Helvetian, and the Upper Coralline limestone to the Tortonian. The relations of Echinoid faunas of the different horizons to those of the corresponding beds in other parts of the Mediterranean are considered, and it is argued that deep-sea conditions prevailed in different areas at different times: hence they show merely a series of local subsidences, instead of one great regional depression.—Prof. Ewart communicated the first part of a paper on the lateral sense-organs of *Læmargus* and *Acanthias*, in which he dealt specially with the sensory canals.—Prof. Tait communicated a paper, by Prof. C. G. Knott, on the electric resistance of cobalt at high temperatures. The cobalt on which Prof. Knott experimented was in the form of a thin strip cut from a sheet in the possession of Prof. Tait. The metal was very pure—containing possibly 1 per cent. of carbon, 0·15 per cent. of silicon, 0·73 per cent. of iron, a very small percentage of manganese, and perhaps 0·1 per cent. of an undetermined metal. The formula $r = a\epsilon^{kt}$, where r is the resistance and t is the temperature, closely represents the results at temperatures above 100° C. This law is identical with that which holds in the case of nickel, but the rate of variation is not so great in cobalt as it is in nickel. When first heated to a very high temperature, profound changes take place in the metal as regards its change of resistance with temperature. The metal resembles nickel and iron in that the rate of variation of its resistance increases rapidly as the temperature rises. But, in nickel and iron, at a still higher temperature, this is followed by a distinct decrease. No such effect is observed in cobalt.—Prof. Tait also read a paper, by the same author, on the thermo-electric positions of cobalt and bismuth. A triple junction of cobalt, bismuth, and palladium was used. A rod of bismuth was formed by breaking the metal into small pieces, and packing them into a siphon-shaped glass tube. Gentle heating fused the pieces, and so a solid rod was formed. The other wires were fused into its ends. The line of this specimen of cobalt, on the thermo-electric diagram, lay, at ordinary temperatures, above that of the specimen of nickel which Prof. Tait used in the construction of the diagram, but a neutral point existed at 100°, because of the greater steepness of the cobalt line. The slope of the line is the greatest which has yet been observed, with the exception of that of the upwardly-sloping portion of the line of nickel. The thermo-electric power of bismuth does not alter in strong magnetic fields, although Righi has shown that its resistance alters in such fields.

SYDNEY.

Royal Society of New South Wales, May 13.—Civil Engineering Section Meeting.—Mr. C. W. Darley in the chair.—The inaugural address was delivered by the Chairman; and a paper read on researches in iron and steel, and working stresses in structures, by Prof. Warren.

June 3.—Mr. W. A. Dixon, Vice-President, in the chair.—Six new members were elected.—The following paper was read:—Notes on the large death-rate among Australian sheep in country affected with Cumberland disease or splenic fever, by M. Adrien Loir, Director of the Pasteur Institute of Australia.—Prof. Anderson-Stuart exhibited his new instrument for demonstrating the manner in which sound-waves are propagated; and Lovibond's tintometer was shown by the Chairman.

PARIS.

Academy of Sciences, July 20.—M. Duchartre in the chair.—The life and works of the late Prof. W. Weber, by M. Mascart.—Observations of minor planets, made with the great meridian instrument of Paris Observatory during the second half of 1890 and the first quarter of 1891, by Admiral Mouchez. The asteroids which have been observed for position are:

(43), (78), (68), (53), (49), (21), (134), (10), (11), (6), (28), (58), (118).

—The third meeting of the International Committee of the map of the heavens: presentation of the Proceedings, by the same author.—Elements of the elliptic comets Swift (1889 VI.) and Spitalier (1890 VII.), by Dr. J. R. Hind.—Evidences that Europe and America have been united during recent times, by M. Emile Blanchard. The evidences given in the author's memoir are derived from a discussion of the fauna and flora of the two continents.—On the glycolysis of circulating blood in living tissues, by MM. R. Lépine and Barral. The authors' method of studying the glycolysis of blood in circulation in an isolated member appears to be more exact than that of studying it *in vitro*. They have used it to prove the diminution of hæmatic glycolysis that occurs in experimental diabetes.—Apparent total disappearance of Jupiter's satellites, by M. C. Flammarion. On July 15, M. Flammarion observed Jupiter when three of his satellites were passing across his disk and one behind it. This rare phenomenon occurs every twenty-three years, a period which contains 523 revolutions of the fourth satellite, 1220 of the third, 2488 of the second, and 4934 of the first. It was first put on record by Galileo in 1611, and M. Flammarion gives a list of seven other observers who have noted it.—Experiments on weirs, by M. H. Bazin.—Vibration of a wire along which an electric current is passing, by M. D. Hurmuzescu. A metallic wire stretched between two supports and traversed by an electric current sets itself in vibration. The amplitude of the vibrations steadily increases and reaches a maximum, which is maintained so long as the current is passing and no changes occur in the conditions of the surrounding medium. For a given tension, the amplitude appears to depend on the difference of temperature of the wire and the medium in which it vibrates; hence it varies as the intensity of the current.—The absorption and photography of colours, by M. Labatut. Using M. Lippmann's method for the photography of the spectrum in its colours, the author has investigated the absorbing action of screens coloured with dyes, such as cyanin, &c., in relation to the parts of the spectrum impressed on the prepared plate and the interference colours produced.—On the composition of atmospheric air: new gravimetric method, by M. A. Leduc. The following represents the results obtained in two experiments:—

	Grms.	Grms.
Weight of air analysed	3·4237	... 3·5551
Weight of oxygen which combined with phosphorus	0·7958	... 0·8249
Percentage proportion of oxygen	23·244	... 23·203

The mean of these values is 23·224, or, roughly, 23·23, which may therefore be taken to represent the percentage of oxygen in purified air. The composition by volume is stated as: nitrogen 78·98 per cent., and oxygen 21·02 per cent.—On silicon selenide, by M. Paul Sabatier. This body has been prepared by passing a current of dry hydrogen selenide over crystallized silicon at a red heat. The selenide obtained is a hard substance, having a semi-metallic appearance, and apparently not volatile at the temperature of the experiment. Its composition, verified by several analyses, is represented by the formula $SiSe_2$.—Melting-point of certain organic binary systems (hydrocarbons), by M. Léo Vignon.—Study of the solid products resulting from the oxidation of drying oils, by M. A. Livache.—On a new method of testing for phenol, by M. L. Carré.—On ozone considered from a physiological and therapeutical point of view, by MM. D. Labbé and Oudin.—On the mode of action of the butyric ferment in the transformation of starch into dextrine, by M. A. Villiers.—On a toxalbumin secreted by a microbe from blennorhagic pus, by MM. Hugounenq and Eraud.—Oscillations of the retina, by M. A. Charpentier. The author has studied experimentally certain phenomena which appear to demonstrate the production of oscillations in the visual organ

under the influence of luminous excitations. These movements are apparently due to a reaction of the retina at the moment when light strikes it.—On the innervation of the stomach of Batrachians, by M. Ch. Contejean.—On the development of the mesoderm of Crustaceæ, and on that of its derived organs, by M. Louis Roule.—On the homology of the pedal and cephalic appendices of Annelidæ, by M. A. Malaquin.—On the muscardine of the white worm, by MM. Prillieux and Delacroix.

BRUSSELS.

Academy of Sciences, May 5.—M. Plateau in the chair. —*Linamarine*, a new glucoside from *Linum Usitatissimum*, yielding hydrogen cyanide on hydrolysis, by A. Jorissen and E. Hairs. The method of preparation found to give the best yield is described. This glucoside presents some points of resemblance with amygdalin, but the table of properties discloses many important differences, notably the solubility of the new body in cold water, its melting at 134° *without decomposition*, and the absence of benzaldehyde from the products of its hydrolysis. The elementary analysis of the new glucoside gives the following figures: C, 47·88; H, 6·68; N, 5·55; O, 39·89.—On the pinacone of desoxybenzoïn, by M. Delacre. The author shows that there are two bodies of the formula $C_{28}H_{26}O_2$ obtained by the reduction of desoxybenzoïn, one consisting of glassy needles melting at 210°, and the other obtained in large crystals melting at 163°. He explains the discordance of the results of MM. Limpricht and Schwanert and M. Zagumenny as being due to the former having obtained the mixed bodies, and hence determined the melting point at 156°.—On the constitution of α-benzopinacoline, by M. Delacre. The author gives a complete chemical and physical study of the properties of this body; he concludes that α-benzopinacoline is not a pinacoline but the ether of benzopinacone, and that its constitution would be expressed by the formula

$$\begin{array}{c}(C_6H_5)_2 : C{-}O{-}C : (C_6H_5)_2 \\ \qquad\qquad | \\ (C_6H_5)_2 : C{-}O{-}C : (C_6H_5)_2\end{array},$$

thus making its molecular weight double that he previously assigned to β-benzopinacoline. The data given in the paper for the determination of the molecular weight of the α-benzopinacoline by the cryoscopic and vapour tension methods would lead to the adoption of the same molecular weight as in the case of the β-benzopinacoline.—On the rate of formation of compound ethers, by N. Menschutkin. A study of the velocity of etherification of some thirty-two alcoholic derivatives, comprising primary and secondary saturated alcohols, tertiary alcohols, primary unsaturated alcohols, alkyl chlorides, alkyl cyanides, and ethers. Acetic anhydride was employed as etherifying agent, as by its use no water was produced, and thus the complication of the problem by the introduction of reversible reactions was avoided. The velocity of etherification of methyl alcohol is the greatest; the substitution of any element or group of elements for hydrogen in the molecule CH_3OH invariably decreases the velocity of the reaction.—Theorems on the curvature of algebraical curves, by Prof. Cl. Servais.—On the "attractive spheres" in some vegetable cells, by E. de Wildeman.—Crystallographic note on albite from Revin, by M. A. Franck.

CRACOW.

Academy of Sciences, May.—On the expansion and compressibility of atmospheric air, by A. W. Witkowski. The author has made experiments with air between the temperatures 100° and −145° C., and at pressures up to 130 atmospheres. The coefficient of expansion (α) has been found at the constant temperatures 100°, 16°, −35°, −78°·5, −103°·5, −130°, −135°, −140°, and −145°, by varying the pressure. The values obtained for these nine isothermals are tabulated and represented graphically. From the isothermal curves it appears that the coefficient of expansion increases up to a maximum in each case, and then diminishes. The increase is most rapid near the liquefaction points. All the curves tend towards a point the co-ordinates of which are $p = 1$ atmosphere, and $\alpha = 0·00367$. The values expressing the compressibility of air have been calculated from the expansion coefficient.—An electrical thermometer for low temperatures, by the same author. The fact utilized in the construction of the instrument is the variation of the resistance of a platinum wire at different temperatures. From the experiments it appears that this is about 2 ohms per degree. It is therefore easy to obtain a sensibility of $\frac{1}{10}$ of a Centigrade degree. The relation between the temperature and the electrical resistance is subject to slight variations if the thermometer is employed for widely different temperatures. This fact has been noted by previous experimenters.—On derivatives of *m*-methyl-*o*-uramidobenzoyls, by S. Niementowski.—On the critical pressure of hydrogens, by K. Olszewski.—Mathematical notions and methods, by S. Dickstein.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Réunion du Comité International Permanent pour l'Exécution de la Carte Photographique du Ciel (Paris, Gauthier-Villars).—Solutions of the Examples in Charles Smith's Elementary Algebra: A. G. Cracknell (Macmillan and Co.).—The Right Hand: Left-Handedness: Sir D. Wilson (Macmillan and Co.).—The Positive Theory of Capital: E. V. Böhm-Bawerk, translated by W. Smart (Macmillan and Co.).—Outside the Class-room: Thoughts for Young Engineers: W. H. Bailey (Manchester, Cornish).—The Skeleton of the Irish Giant, Cornelius Magrath; D. J. Cunningham (Williams and Norgate).—Die Jährliche Parallaxe des Sterns Oeltzen 11677: Dr. J. Franz (Königsberg).—The Photochronograph and its Application to Star Transits (Washington).—The Geological and Natural History Survey of Minnesota, Eighteenth Annual Report, 1889: N. H. Winchell (Minn.).—The Iron Ores of Minnesota: N. H. Winchell and H. V. Winchell (Minn.).—Thirty-eighth Report of the Department of Science and Art (Eyre and Spottiswoode).—Abbildungen zur Deutschen Flora: H. Karsten's (Berlin, Friedländer).—Anatomie des Hundes: Dr. W. Ellenberger and Dr. H. Baum (Berlin, P. Parey).—The Telescope: J. W. Williams (Sonnenschein).—Les Engrais Chimiques: Tome Premier, Les Principes et la Théorie: M. G. Ville (Paris).—An Explanation of the Constitution of the Ether, of the Constitution of Matter, and of the Cause of Universal Gravitation: J. G. Vine (Reeves).—Peabody Institute of the City of Baltimore, Twenty-Fourth Annual Report, June 4, 1891 (Baltimore.)—Proceedings of the Boston Society of Natural History, vol. xxv., Part 1 (Boston).—Notes from the Leyden Museum, vol. xiii., No. 2 (Leyden, Brill).—Contributions from the U.S. National Herbarium, vol. i., No. 4 (Washington).

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